

The Lower and Middle Tithonian Ammonite Fauna from Cerro Lotena, Province of Neuquen, Argentina.

BY

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With 10 text figures and plates 1—9

ABSTRACT

The present monograph deals with the description of the ammonite fauna from Cerro Lotena, located in the south central part of the Neuquén province, Argentine Republic. The stratigraphic section investigated occurs on the southern slope of Cerro Lotena. In this section the following formations were distinguished in ascending order: the Vaca Muerta Formation (129 m), the Picún Leufú Formation (57 m) and the Mulichinco Formation (101 m) *pars*. The entire ammonite fauna described here is from the Vaca Muerta Formation. The Picún Leufú Formation, characterized by a coastal facies of bivalves contains ammonites only sporadically. The Vaca Muerta Formation is attributed to the Lower and Middle Tithonian, the Picún Leufú Formation to the Upper Tithonian and the Mulichinco Formation to the Berriasian.

The fauna consists of 5 families, 16 genera, 30 species and 2 subspecies. Of these, one genus, 6 species and one subspecies are new, as follows: *Choicensisphinctes* gen. nov., *Glochiceras steueri* n. sp., *Hildoglochiceras wiedmanni* n. sp., *Parastreblites comahuensis* n. sp., *Subdichotomoceras araucanense* n. sp.,

Pachysphinctes americanensis n. sp., *Virgatosphinctes evolutus* n. sp. and *Choicensisphinctes choicensis sutilis* n. ssp. The genera *Hildoglochiceras*, *Parastreblites*, *Pachysphinctes* and *Parapallasiceras* are cited for the first time from the Andean Tithonian.

The fauna can be grouped in 4 associations that basically correspond to ammonite zones previously established by others authors, as follows: *Virgatosphinctes mendozanus* Zone, *Pseudolisoceras zitteli* Zone, *Aulacosphinctes proximus* Zone and *Windhausenicerias internispinosum* Zone. Considering the tripartite division of the Tithonian adopted here, the first zone corresponds to the uppermost Lower Tithonian and the remaining three to the Middle Tithonian. The age and other features of these zones are considered, and suggestions are made toward improving their definition.

The described fauna shows close affinities principally with those of Mexico, Madagascar and India, and to a lesser extent with those of the Mediterranean Realm. No true Boreal elements have been found.

KURZFASSUNG

Es wird die Ammonitenfauna des Cerro Lotena beschrieben, der im Süden des zentralen Teils der Provinz Neuquén (Argentinien) liegt. Das hier beschriebene Profil ist am Südhang des Cerro Lotena abgeschlossen. Von unten nach oben werden folgende Formationen unterschieden: Vaca Muerta-Formation (129 m), Picún Leufú-Formation (57 m) und Mulichinco-Formation (101 m) *pars*. Die hier beschriebene Ammonitenfauna stammt aus der Vaca Muerta-Formation, die Unterem und Mittlerem Tithon entspricht. Die dem Oberen Tithon entsprechende Picún Leufú-Formation ist in Litoralfazies mit Bivalven und nur sporadischen Ammoniten entwickelt. Die Mulichinco-Formation entspricht dem Berrias.

Die hier beschriebene Fauna besteht aus 5 Familien, 16 Gattungen, 30 Arten und 2 Unterarten. Davon sind 1 Gattung, 6 Arten und 1 Unterart neu, und zwar *Choicensisphinctes* n. g., *Glochiceras steueri* n. sp., *Hildoglochiceras wiedmanni* n. sp., *Parastreblites comahuensis* n. sp., *Subdichotomoceras araucanense* n. sp., *Pachysphinctes americanensis* n. sp., *Virgatosphinctes evolutus* n. sp. und *Choicensisphinctes choicensis sutilis* n. ssp. Die Gattungen *Hildoglochiceras*,

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Parastreblites, *Pachysphinctes* und *Parapallasiceras* werden zum ersten Mal aus dem andinen Tithon beschrieben.

Die Fauna kann in vier Associationen gruppiert werden, die im wesentlichen bereits bestehenden Ammonitenzonen entsprechen. Es sind dies die Zone des *Virgatosphinctes mendozanus*, die Zone des *Pseudolissoceras zitteli*, die Zone des *Aulacosphinctes proximus* und die Zone des *Windhausenicerias internispinosum*.

Da hier der Dreigliederung des Tithon gefolgt wird, entspricht die erstgenannte Zone dem höchsten Untertithon, die drei übrigen Zonen dem Mitteltithon. Die Zonengliederung wird ausführlich diskutiert.

In paläogeographischer Hinsicht zeigt die Fauna enge Beziehungen zu Mexico, Madagascar und Indien, dagegen geringere Verbindungen zur mediterranen Faunenprovinz. Boreale Faunenelemente sind demgegenüber nicht nachweisbar.

RESUMEN

La presente monografía trata acerca de la descripción de la fauna de ammonites del Cerro Lotena, situado en la parte sud central de la provincia del Neuquén, República Argentina. Se ofrece la sección estratigráfica levantada en el faldeo sur del Cerro Lotena, donde se distinguen en orden ascendente las Formaciones Vaca Muerta (129 m), Picún Leufú (57 m) y Mulichinco (101 m) *pars*. La totalidad de la fauna de ammonites estudiada procede de la Formación Vaca Muerta. La Formación Picún Leufú, caracterizada por una facies costera de bivalvos, posee ammonites sólo muy esporádicamente. Según los resultados alcanzados, la Formación Vaca Muerta se atribuye al Tithoniano inferior y medio, la Formación Picún Leufú al Tithoniano superior y la Formación Mulichinco al Berriasiano.

El estudio de la fauna permitió individualizar 5 familias, 16 géneros, 30 especies y 2 subespecies. De ellos, un género, 6 especies y una subespecie son nuevos, a saber: *Choicensisphinctes* gen. nov., *Glochiceras steveri* n. sp., *Hildoglochiceras wiedmanni* n. sp., *Parastreblites comahuensis* n. sp., *Subdichotomoceras araucanense* n. sp., *Pachysphinctes americanensis* n.

sp., *Virgatosphinctes evolutus* n. sp. y *Choicensisphinctes choicensis sutilis* n. ssp. Los géneros *Hildoglochiceras*, *Parastreblites*, *Pachysphinctes* y *Parapallasiceras* se citan por primera vez en el Tithoniano andino.

La fauna estudiada puede agruparse en 4 asociaciones que básicamente responden a zonas de ammonites previamente establecidas por otros autores, a saber: Zona de *Virgatosphinctes mendozanus*, Zona de *Pseudolissoceras zitteli*, Zona de *Aulacosphinctes proximus* y Zona de *Windhausenicerias internispinosum*. Según la división tripartita del Tithoniano aquí adoptada, la primera zona corresponde al más alto Tithoniano inferior, mientras que las tres restantes indican el Tithoniano medio. Se efectúan consideraciones y aportes que permiten ampliar el conocimiento de cada una de ellas, así como precisar su edad con mayor exactitud.

La fauna descrita presenta estrechas afinidades principalmente con aquéllas de México, Madagascar e India y, en menor grado, con aquéllas del dominio mediterráneo. No se hallaron elementos boreales en la fauna estudiada.

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I. INTRODUCTION

The description of the ammonite fauna from Cerro Lotena, which is the basis of this monograph, was necessary in order to advance our knowledge of the Andean Tithonian. Although important progress related to the Upper Jurassic and Lower Cretaceous was made by A. F. LEANZA (1945), who described the ammonite fauna from Sierra Azul, the Lower and Middle Tithonian faunas have not been sufficiently investigated. The Sierra Azul was a topographically elevated area during most of the Jurassic period and, therefore, the Tithonian transgression begins in this area with the *Windhausenicerias internispinosum* Zone, which is poorly documented and contains only *Widmannicerias mirum* in association with the index species. Above this zone the ammonites become abundant up to the late Valanginian, including the transition from the Jurassic to the Cretaceous.

Knowledge concerning the Lower and Middle Tithonian, however, has not appreciably improved since the classic monographs of BURCKHARDT (1900a, 1900b, 1903), HAUPT (1907), KRANTZ (1926, 1928) and WEAVER (1931). The work of INDANS (1954), although referred to the Lower Tithonian, deals exclusively with the Virgatospinctinae Beds at the base of the Tithonian transgression in southern Mendoza, and therefore does not allow zonation of the Tithonian.

As anticipated by GROEBER (in A. F. LEANZA, 1945, p. 85), knowledge of the Andean Tithonian could be improved by the study of the Cerro Lotena fauna. Since this fauna extends downwards from the *W. internispinosum* Zone, it provides important information on the earlier part of the Tithonian.

The collection of ammonites described here was made by Dr. Anselmo WINDHAUSEN during the summer of 1912. It was archived in the repository of the Museo de la Secretaría de Minería of the Argentine Republic. Part of this collection was temporarily sent to Tübingen in order to carry out the present study. The specimens were numbered according to the outlines of the stratigraphic section made by WINDHAUSEN (1914, table VIII), and they were subdivided in correspondence with WINDHAUSEN's profiles I to III, which he later respectively identified as

"Kimmeridge-Portland", "Lower Tithonian" and "Upper Tithonian".

The death of A. F. LEANZA in 1975 prevented his intended description of the WINDHAUSEN collection. The present author, however, has had several opportunities, beginning in 1970, to visit the Cerro Lotena area in association with a phosphate exploration programme carried out by the Secretaría de Minería of the Argentine Republic. As a result, revision of WINDHAUSEN's section and relocation of his collected samples has been carried out.

A visitor to the Cerro Lotena area today will surely not find specimens of quality comparable to those figured here from the WINDHAUSEN collection. The fact that this area is relatively accessible, and close to oil fields and kaolin and bentonite mines, has led to invasions of tourists and collectors who over the years have removed a large amount of scientifically valuable material.

A c k n o w l e d g e m e n t s

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This monograph is dedicated to the memory of my father, Prof. Dr. Armando F. LEANZA.

II. PREVIOUS WORK

In the year 1907, Oscar HAUPT described a fossil assemblage composed of cephalopods, pelecypods, brachiopods, echinoderms, worms and fishes from Cerro Lotena. The material on which HAUPT based his study was collected by Gustav STEINMANN during his study trip to the Andes in the years 1902 and 1903. A few years later, R. DOUVILLÉ (1910) published the

results of his paleontological investigations on cephalopods collected by M. RECOPE. Though DOUVILLÉ (1910, p. 5) stated that the fossils came from a region between the Agrio river and the Picún Leufú creek, it is likely that most of them are from the Cerro Lotena area since at this time RECOPE was working as inspector at the oil concession at Cerro Lotena.

The ammonites studied by HAUPT and DOUVILLÉ became rapidly known in the scientific world because the latter author favoured the presence of Boreal elements in this region of the Andes. This was just at the time when the legendary discussion between the great ammonitologists Charles BURCKHARDT (1911a, 1911b) and Victor UHLIG (1910, 1911a, 1911b) regarding the presence or absence of ammonites with Boreal affinities in the Andean domain, reached its most intense point.

It was at this time, with an interest in both the presence of oil and the supposed presence of Boreal ammonite faunas in this region, that WINDHAUSEN visited Cerro Lotena in 1912. There, with the help of A. FLOSSDORF, he collected the ammonites described in this monograph. Two years later, WINDHAUSEN (1914) gave a summary of his results, illustrating for the first time and with particular detail the Cerro Lotena section.

New geological descriptions of the area were later made, as a result of its petroliferous potential by J. KEIDEL (1925). One year later F. KRANTZ (1926) published an important paper on Middle and Upper

Tithonian ammonites, describing some species from Cerro Lotena. A translation of this work into Spanish appeared two years later (F. KRANTZ, 1928). Ch. WEAVER (1931) also presented very important biostratigraphical data for the Cerro Lotena, including its stratigraphical section.

Regional mapping of the area was carried out by T. SUERO (1942, 1951), who mapped the Hoja 36 c, Cerro Lotena, at a 1:200 000 scale.

More recently, detailed studies of the stratigraphy of this area have been made (H. LEANZA, 1973; H. LEANZA, H. MARCHESE & J. C. RIGGI, 1977; H. LEANZA & C. HUGO, 1977). Z. GASPARINI & D. DELLAPE (1976) also have presented stratigraphic data relating to the occurrence of fossil crocodiles in the Vaca Muerta Formation.

It is also important to mention the classic monographs of O. BEHRENDSEN (1891—1892; 1922, transl.), A. STEUER (1897; 1921, transl.), H. GERTH (1925, 1926), A. F. LEANZA (1945) and J. INDANS (1954), in which a great number of cephalopods were described from the Neuquén and Mendoza basin; these are directly or indirectly related to the fauna described here.

III. STRATIGRAPHY

The Cerro Lotena is located 70 km south east of Zapala, in the southern part of the Neuquén province, Argentina (see Fig. 1).

The stratigraphic section described below was measured on the southern slope of Cerro Lotena, and

consists of the following Formations: Vaca Muerta (WEAVER, 1931, *emend.* H. LEANZA, 1972, 1973), Picún Leufú (H. LEANZA, 1973) and Mulichinco (WEAVER, 1931). All these Formations constitute part of the Mendoza Group. The stratigraphy of the area can be summarized as follows:

Campanian- Santonian	Candeleros Formation	Neuquén Group <i>pars</i>
_____	U n c o n f o r m i t y	_____
Lower Berriasian	Mulichinco Formation	
_____	_____	
Upper Tithonian	Picún Leufú Formation	Mendoza Group <i>pars</i>
_____	_____	
Middle Tithonian Lower Tithonian	Vaca Muerta Formation	
_____	U n c o n f o r m i t y	_____
Calovian	Lotena Formation	

The ammonite faunas studied in this monograph are entirely from the Vaca Muerta Formation. The beds of this formation strike nearly east-west and dip about 20° to the south, a value which decreases slightly upsection. The Vaca Muerta Formation rests unconformably upon the Lotena Formation by means of a basal conglomerate termed the Quebrada del Sapo

Formation by some authors (cf. DIGREGORIO, 1972), and is conformably overlain by the Picún Leufú Formation, which is characterized by a coastal facies of bivalves. Ammonites are rare in this latter formation but sufficient to postulate an Upper Tithonian age (cf. H. LEANZA & C. HUGO, 1977, p. 253).

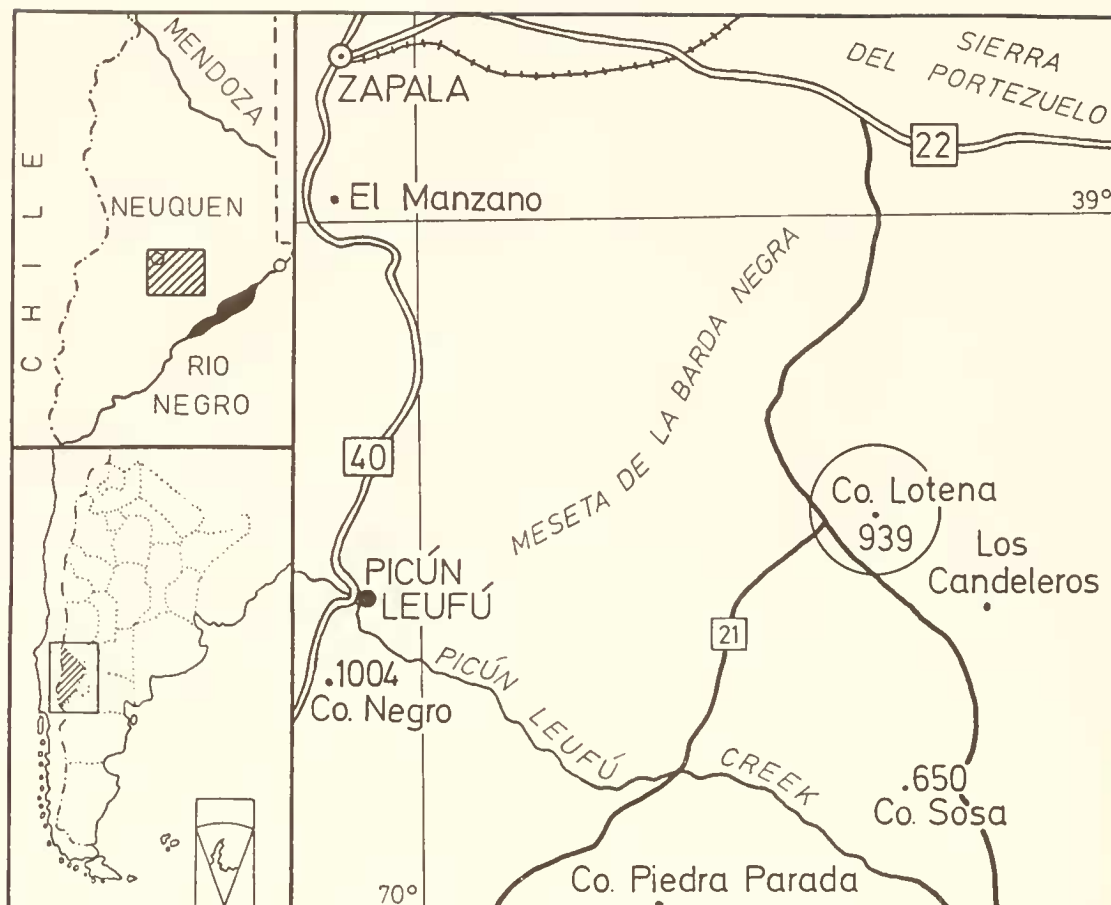


Figure 1: Sketch map of the Cerro Lotena area.

Description of the Cerro Lotena Section

The lithological characteristics of the sediments of the stratigraphic section, as well as its paleontological contents, are as follow (from top to base):

Top: base of the Mulichinco Formation

Picún Leufú Formation H. LEANZA, 1973. Total thickness: 57 m

Bed 36: 0.80 m fine grained calcarenite, yellowish white, hard.

Bed 35: 4.20 m brownish calcarenite, with *Pholadomya gigantea* SOW., *Lucina leufuensis* WEAV. and *Panope dupiniana* d'ORB.

Bed 34: 4.00 m fine grained calcarenite, yellowish. At the base are quartz geodes. In the more calcareous portion are *Myoconcha transatlantica* BURCK. and *Lucina leufuensis* WEAV.

Bed 33: 2.00 m fine banded calcareous sandstone, yellowish brown.

Bed 32: 2.00 m yellowish white coquina, with *Lucina neuquensis* HAUPT, *Pholadomya gigantea* SOW. and *Panope dupiniana* d'ORB.

Bed 31: 5.00 m fine grained calcareous sandstone, brownish, fissile.

Bed 30: 0.70 m yellowish white coquina, with *Pholadomya gigantea* SOW., *Lucina leufuensis* WEAV. and *Panope* sp.

Bed 29: 6.30 m fine grained calcarenite, brownish.

Bed 28: 0.80 m yellowish white coquina, with *Ostrea minus* COQ., *Panope dupiniana* d'ORB. and *Lucina leufuensis* WEAV.

Bed 27: 7.20 m dark green shales.

Bed 26: 8.00 m yellowish white coquina, which constitutes an excellent guide horizon. *Ostrea minus* COQ., *Ostrea lotenoensis* WEAV., *Megatrigonia eximia* (PHIL.), *Panope dupiniana* d'ORB. and *Substeueroceras* sp. indet.

Bed 25: 14.00 m fine grained calcareous sandstone, fissile, with some aragonitic horizons. *Ostrea lotenoensis* WEAV., *Exogyra couloni* (DEFR.) d'ORB. and *Lucina neuquensis* HAUPT.

Bed 24: 2.00 m brownish coquina, with *Exogyra couloni* (DEFR.) d'ORB. sp. juv., *Lucina neuquensis* HAUPT and *Serpula* sp.

Vaca Muerta Formation WEAVER, 1931, *emend.*
H. LEANZA, 1972. Total thickness: 129 m.

Bed 23: 25.00 m dark olive-green shales, with some bentonitic levels. *Ostrea lotenoensis* WEAVER and *Serpula antiquata* SOW.

Bed 22: 0.40 m pinkish-gray limestone, with *Windhausenicerias internispinosum* (KRANTZ) and *Pachysphinctes americanensis* n. sp.

Bed 21: 1.60 m olive-green and dark gray marls.

Bed 20: 0.20 m pinkish-gray massive limestone, with *Hemispiticerias* aff. *H. steinmanni* (STEUER).

Bed 19: 0.80 m dark olive-green marls.

Bed 18: 0.50 m pinkish-gray massive limestone, with *Parapallasiceras* sp. indet.

Bed 17: 4.00 m olive-green marls and shales.

Bed 16: 0.30 m yellowish-white massive limestone, with *Subdichotomoceras windhauseni* (WEAVER), *W. internispinosum* (KRANTZ), *Corongoceras lotenoense* SPATH and *Parapallasiceras* aff. *P. pseudocolumbrinoides* OLORIZ.

Bed 15: 3.20 m yellowish-green marls.

Bed 14: 0.40 m yellowish-grey massive limestone, with *W. internispinosum* (KRANTZ) and *Aulacosphinctoides* aff. *A. bundesianus* (UHLIG).

Bed 13: 3.00 m yellowish-grey marls.

Bed 12: 0.80 m yellowish-grey massive limestone, with *Subdichotomoceras araucanense* n. sp. and *Aulacosphinctoides* sp. indet.

Bed 11: 2.00 m yellowish-brown marls.

Bed 10: 0.80 m greyish-white limestone, with *Parapallasiceras* aff. *recticosta* OLORIZ, and *A. euomphalum* STEUER.

Bed 9: 4.00 m dark brownish-grey shales. *W. internispinosum*

Bed 8: 10.00 m greenish marls and shales.

Bed 7: 21.00 m greenish and dark brownish shales,

with many nodules and calcareous concretions. Abundant *Aulacosphinctes proximus* (STEUER) and *Laevaptychus crassissimus* (HAUPT), and rare *Subdichotomoceras* sp. juv. indet.

Bed 6: 10.00 m dark brown shales, with *Pseudolissoceras zitteli* (BURCK.) and *P. pseudooolithicum* (HAUPT). Remains of fish scales and *Ichthyosaurus* bones.

Bed 5: 0.70 m dark grey limestone, with some quartz veins. *P. zitteli* (BURCK.) and *Parastreblites comabuensis* n. sp.

Bed 4: 14.30 m dark brown shales, with *P. zitteli* (BURCK.).

Bed 3: 1.00 m grey brownish limestone with *P. zitteli* (BURCK.) and rare *Glochiceras steueri* n. sp. and *Hildoglochiceras wiedmanni* n. sp.

Bed 2: 25.00 m brown, yellowish-brown and dark green bituminous shales (Virgatosphinctinae Beds). At the top are remains of *Geosaurus araucanensis* (Crocodilia). Ammonites: *Pseudinvoluticeras douvillei* SPATH, *P. windhauseni* (WEAVER), *P. (?) wilfridi* (DOUV.), *Virgatosphinctes andesensis* (DOUV.), *V. mexicanus* (BURCK.), *V. burckhardtii* (DOUV.), *V. densplicatus rotundus* SPATH, *V. evolutus* n. sp., *Choicensisphinctes choicensis* (BURCK.), *Ch. choicensis suttilis* n. ssp. and *Ch. erinoides* (BURCK.).

Bed 1: 0.50 m to 5.00 m basal conglomerate with rounded clasts of quartz, porphirites and pre-Tithonian sedimentary rocks, up to 4 cm of diameter. Several strongly eroded Virgatosphinctinae fragments also present. The conglomerate constitutes the Quebrada del Sapo Formation of some authors (cf. DIGREGORIO, 1972).

Unconformity

Base: Lotena Formation WEAVER, 1931, Calovian.

IV. ANALYSIS OF THE FAUNA

The Cerro Lotena ammonite fauna described here comprises 156 specimens, which are distributed amongst 5 families, 16 genera, 30 species and 2 sub-species. Of these, one genus, 6 species and one sub-species are new. The family Perisphinctidae constitutes 66 % of the fauna, followed by the families Berriasellidae and Haploceratidae with 13 % each. The remaining 8 % is represented by the families Oppeliidae and Aspidoceratitidae. The systematic descriptions follow the order proposed by ARKELL *et al.* (1957) in the Treatise of Invertebrate Paleontology.

The family Haploceratidae is represented by the genera *Pseudolissoceras*, *Glochiceras* and *Hildoglochiceras*. The genus *Pseudolissoceras* is very important because it is a cosmopolitan form, known not only

from the Andean Tithonian of South America (BURCKHARDT, 1903; HAUPT, 1907; KRANTZ, 1926, 1928; WEAVER, 1931), Cuba (IMLAY, 1942) and Mexico (BURCKHARDT, 1906; VERMA & WESTERMANN, 1973), but also in such distant regions as Tunisia (ARNOULD-SAGET, 1951, 1951a), Iraq (SPATH, 1950), Spain (OLORIZ, 1978), southeast France (DONZE & ENAY, 1961), south Germany (BARTHEL, 1962), the Carpathians (ZITTEL, 1870), Rumania (AVRAM, 1976) and Italy (*vide* ENAY, 1972). In Cerro Lotena 2 species of this genus were found and identified as *P. zitteli* (BURCK.) and *P. pseudooolithicum* (HAUPT). The first species is particularly abundant, and gives the name to the *P. zitteli* Zone, which belongs to the Lower or Middle Tithonian depending on whether the bi- or tripartite division of the Tithonian is used.

The genus *Glochiceras* is abundant in the European White Jura (cf. ZIEGLER, 1958) and has also been reported from the Tithonian and/or Kimmeridgian of Mexico (CASTILLO & AGUILERA, 1895; BURCKHARDT, 1906; IMLAY, 1939) and Argentina (KRANTZ, 1926, 1928; STEUER, 1897, 1921) as well as from Russia (ZONOV, 1937), Madagascar (COLLIGNON, 1960), Somaliland (SPATH, 1925), Tanganyika (DIETRICH, 1933), Iraq (SPATH, 1950), India (SPATH, 1927—33), Rumania (AVRAM, 1976) and Japan (YOKOYAMA, 1904, revised by ARKELL, 1956). The species from Cerro Lotena is new and is named *G. steueri* n. sp., with *Oppelia nimbata* STEUER (*non* OPPEL) as the type species. It was found in strata belonging to the *P. zitteli* Zone.

The genus *Hildoglochiceras* also has a world wide distribution, and is known from beds of generally Lower Tithonian age from the Himalayas (UHLIG, 1903—10), India (SPATH, 1927—33), Tanganyika (ZWIERZYCKI, 1914), Madagascar (COLLIGNON, 1960), Mexico (IMLAY, 1939) and Cuba (IMLAY, 1942). The only species found in Cerro Lotena is new and is named *H. wiedmanni* n. sp.. It also belongs to the *P. zitteli* Zone.

The family Oppeliidae is represented by a new species of the genus *Parastreblites*, which was originally described as a subgenus of *Taramelliceras* from Lower Tithonian beds at Saint Concors, southeast France (DONZE & ENAY, 1961). The species from Cerro Lotena is closely related to *P. waageni* (OPPEL), formerly included by SPATH (1925) in *Neohetoceras*, and is named *P. comahuensis* n. sp.

The family Perisphinctidae constitutes 66% of the studied fauna, but most of its representatives belong to the subfamily Virgatosphinctinae, with the following genera present: *Subdichotomoceras*, *Pachysphinctes*, *Aulacosphinctoides*, *Parapallasiceras*, *Virgatosphinctes*, *Pseudinvoluticeras* and *Choicensisphinctes* gen. nov.

The genus *Subdichotomoceras*, which can only be distinguished from *Pavlovia* by the less densely-ribbed internal whorls, is represented in Cerro Lotena, by three species, one of them new: *S. windhausenii* (WEAV.), *S. araucanense* n. sp., and *S. sp. juv. indet.* This genus has also been recorded in England (SPATH, 1925), Spain (OLORIZ, 1978), Somaliland (SPATH, 1925), Kenya (SPATH, 1930), Tanganyika (DIETRICH, 1933), Madagascar (COLLIGNON, 1960), India (SPATH, 1927—33), Greenland? (SPATH, 1936) and Mexico (VERMA & WESTERMANN, 1973). The Cerro Lotena specimens occur in the *A. proximus* and *W. internispinosum* Zones of the Middle Tithonian. Though the presence of *Subdichotomoceras* is known in Argentina, the specimens illustrated here are the first to be originally described under this name.

The genus *Pachysphinctes* is reported here for the

first time from the Andes of South America, under the name of *P. americanensis* n. sp. This genus is a common form in the Middle Katrol Beds of Cutch, India, where it occurs in association with *Subdichotomoceras* (cf. SPATH, 1927—33). The same association is also present in the Tendaguru Group in the east of Africa (cf. SPATH, 1930; DIETRICH, 1925, 1933), and in southern Spain (OLORIZ, 1978). In Cerro Lotena it also occurs in association with *Subdichotomoceras*, in the *W. internispinosum* Zone.

The genus *Aulacosphinctoides* is represented in Cerro Lotena by a form very similar to *A. hundesianus* (UHLIG) from the Spiti Shales, and by another form whose poor preservation prevents specific classification. *Aulacosphinctoides* is another typical Tithonian genus of world wide distribution, very common in New Zealand (SPATH, 1923; STEVENS, 1968), the Himalayas (UHLIG, 1903—10), India (SPATH, 1927—33), Somaliland (SPATH, 1925), Japan (cf. ARKELL, 1956) and Mexico (VERMA & WESTERMANN, 1973). In Argentina, its presence was suggested by ARKELL (1956, p. 583) on the basis of examination of the ammonite fauna illustrated by INDANS (1954) from south Mendoza; however the forms described here are the first from Argentina originally referred to by this name.

Within the genus *Parapallasiceras*, typical of the Lower and Middle Tithonian (cf. ZEISS, 1968), three species have been distinguished: *P. aff. P. pseudocolubrinoide* OLORIZ, *P. aff. P. recticosta* OLORIZ, and *P. sp. indet.* All three species are from the *W. internispinosum* Zone at Cerro Lotena.

The genus *Virgatosphinctes* has a world wide distribution and is known from Europe (cf. ARKELL, 1956), north Africa (ROMAN, 1936), Somaliland (SPATH, 1925), Abyssinia (CRICK, 1897, revised by SPATH, 1925), Tanganyika (ARKELL, 1956), Madagascar (COLLIGNON, 1960; BESAIRIE, 1936; LEMOINE, 1911), Persia (CLAPP, 1940), Cutch (SPATH, 1927—33), Baluchistan (ARKELL, 1956), the Himalayas (UHLIG, 1903 bis 1910), Pakistan (FATMI, 1972), Australia (BRUNN-SCHWEILER, 1954), Mexico (IMLAY, 1939; VERMA & WESTERMANN, 1973), Cuba (IMLAY, 1942), Trinidad (HUTCHINSON, 1938), Chile (CORVALÁN & PEREZ, 1958) and Argentina (WEAVER, 1931; INDANS, 1954). This genus is common in the Lower Tithonian as well as in the Upper Tithonian. Though the presence of *Virgatosphinctes* in the Andean domain has been questioned in some cases, it is well documented from the Cerro Lotena section, and is represented by the following species: *V. andesensis* (DOUV.), *V. mexicana* (BURCK.), *V. denseplicatus rotundus* SPATH, *V. burckhardti* (DOUV.), and *V. evolutus* n. sp.

The genus *Pseudinvoluticeras*, typical of the Lower Tithonian, has been reported from Somaliland (SPATH, 1925), Madagascar (COLLIGNON, 1960), Ana-

tolia (*fide* ENAY, 1972), Mexico (VERMA & WESTERMANN, 1973) and Argentina (SPATH, 1925, 1950). In Cerro Lotena two, or possibly three species, have been found, named *P. douvillei* SPATH, *P. windhauseni* (WEAV.), and *P. (?) wilfridi* (DOUV.). The identification of this last species is questionable because it is based on internal whorls of a single specimen which could also belong to *Aulacosphinctoides*. *P. "decipiens"* SPATH is considered synonymous with the first species.

The genus *Choicensisphinctes* is here proposed in order to group together certain ammonites having inflated shells of olcostephanid aspect, and ornamentation composed of fascicules with 4 to 10 ribs.

These ammonites constitute a homogeneous stock which includes the following species of BURCKHARDT: "*P.*" *choicensis* (type species), "*P.*" *erinoides* and possibly "*P.*" aff. *erinus*. The proposal of this genus follows the original suggestion by UHLIG (1911a, p. 542) that these species could belong to a particular group of ammonites. It should be noted that *Ch. choicensis* is the most common species in the basal beds of the Vaca Muerta Formation within the Neuquén and Mendoza basin, and has been found by the author, in addition to Cerro Lotena, at Mallín de los Caballos, Mallín Quemado, Cajón de Almaza and Bardas Blancas (cf. H. LEANZA & C. HUGO, 1977). *Virgatosphinctes* cf. *raja* INDANS (*non* UHLIG) is included in the synonymic list of *Ch. choicensis*. In Cerro Lotena the genus *Choicensisphinctes* is represented by two species and one subspecies, as follows: *Ch. choicensis*, *Ch. choicensis sutilis* n. ssp. and *Ch. erinoides*. These species are common in the *V. mendozanus* Zone at the base of the Tithonian transgression.

Finally, it should be remarked that the genus *Torquatisphinctes*, although it is not represented in the fauna described here, it has been found by the author at Cerro Lotena in the mandibles of a crocodile — *Geosaurus araucanensis* — (cf. GASPARINI & DELLAPE, 1976) in the lower part of the Vaca Muerta Formation, as well as in other parts of the Neuquén and Mendoza basin (cf. H. LEANZA & C. HUGO, 1977).

The genera *Virgatosphinctes*, *Pseudinvoluticeras* and *Choicensisphinctes*, as well as *Torquatisphinctes*, occur together at the base of the Vaca Muerta Formation, within the *V. mendozanus* Zone (= *Virgatosphinctinae* Beds).

The family Aspidoceratidae is represented by only one genus and one species: *Aspidoceras euomphalum* STEUER. In the Cerro Lotena area, however, *A. haupti* KRANTZ (1926) and *A. neuquensis* WEAVER (1931) as well as *A. steinmanni* HAUPT, the type species of the genus *Pseudhimalayites* SPATH (1925) have also been reported. The genus *Aspidoceras* is very cosmopolitan and is common in sediments of Tithonian age.

The family Berriasellidae is represented exclusively

in the described fauna by the subfamily Himalayitinae, containing the genera *Windhauseniceras*, *Hemispiticeras*, *Aulacosphinctes* and *Corongoceras*.

The genus *Windhauseniceras*, which is apparently endemic, is very well represented by its type species *W. internispinosum*. This species is very abundant and next to *P. zitteli*, is the commonest form in Cerro Lotena. It gives the name to the *W. internispinosum* Zone, which in this monograph is placed in the upper part of the Middle Tithonian.

The genus *Hemispiticeras* is represented by a single specimen that closely resembles its type species "*R.*" *steinmanni* STEUER, differing only by having a less obvious lateroventral row of tubercles. It is therefore regarded as *H.* aff. *H. steinmanni* (STEUER).

The genus *Aulacosphinctes* is well represented in Cerro Lotena by a single species identified as *A. proximus* (STEUER). This typical Tithonian genus is known from Algeria (ROMAN, 1936), Somaliland (SPATH, 1925), Abyssinia (CRICK, 1897, revised by SPATH, 1925), Madagascar (COLLIGNON, 1960), Cutch (SPATH, 1927—33), the Himalayas (UHLIG, 1903—10), Pakistan (FATMI, 1972), California? (IMLAY, 1952), Argentina (STEUER, 1897, 1921; WEAVER, 1931; A. F. LEANZA, 1945; INDANS, 1954) and in Chile (CORVALÁN, 1959). The described species is particularly abundant in the Cerro Lotena section in the beds occurring between the *P. zitteli* and *W. internispinosum* Zones.

The genus *Corongoceras* is represented in Cerro Lotena by its type species *C. lotenoense*. This genus is widely distributed in the Andean Tithonian. Apart from the type species referred to by SPATH (1925, p. 144) from Corongo, Perú, 5 further species are known in South America, as follows: *C. mendozanum* (BEHR.), *C. alternans* (GERTH), *C. duraznense* KRANTZ, *C. submendozanum* KRANTZ and *C. rigali* LEANZA. In Cuba *C. filicostatum* IMLAY (1942) and in Mexico *C. mendozanum* and *C. cordobai* VERMA & WESTERMANN (1973) have been recorded. Elsewhere in the world the genus is known from Madagascar (COLLIGNON, 1960), Algeria (ROMAN, 1936), Nepal (HELMSTEADT, 1969) and Spain (OLORIZ, 1978). The species from Cerro Lotena occurs in the beds of the *W. internispinosum* Zone. Field observations indicate that it is not common in the overlying *C. alternans* Zone of the Upper Tithonian (cf. A. F. LEANZA, 1945).

No true Boreal elements have been recorded in the fauna from Cerro Lotena. It should also be remarked that no representatives of the genera *Lytoceras* or *Phylloceras* have been found. This feature, considering the paleogeographical and paleoenvironmental conditions under which the Vaca Muerta Formation was deposited, favours the suggestion of SPATH (1932, p. 151, 152) that these were pelagic organisms which were not adapted to living in shallow epicontinental seas.

Preservation of the ammonite
fauna

The degree of preservation of the fossils depends upon their stratigraphic position. In the lower part of the Vaca Muerta Formation (*V. mendozanus* and *P. zitteli* Zones), most of the specimens have been affected by diagenetic compaction and usually one side is better preserved than the other. All the fossils are calcified, with calcite crystals commonly present in the camerae. Oysters are attached to some specimens, particularly to the umbilicus and appear to be true

epizoans. Specimens are generally dark grey in colour and the suture line can be observed in most cases.

In the upper part of the Vaca Muerta Formation (*A. proximus* and *W. internispinosum* Zones) the ammonite shells are commonly occurring as recrystallized to white yellowish-white, granular, calcium carbonate. Both the fossils and the matrix consists of the same material, and the test of the shell is usually preserved. The suture lines are not preserved in any specimens, a fact which creates a serious problem in the determination of taxonomic position.

V. TAXONOMIC REVISION

The classification used here at the generic level is in accordance with the Treatise of Invertebrate Paleontology (ARKELL *et al.*, 1957). *Parastreblites* DONZE & ENAY (1961) is regarded as a genus and not a subgenus of *Taramelliceras* as originally described. In Table I

the suggested taxonomic changes are summarized. The reasons for these changes are given in the discussions of the respective genera and species in the systematic descriptions.

TABLE I
Revision of Ammonite Species

Previous classification	New classification
<i>Pseudolissoceras zitteli</i> (BURCK.) ARNOULD-SAGET, 1951, p. 9, Pl. I, figs. 12a-c, 13a-c, 14, 16a-c	? <i>Pseudolissoceras pseudooolithicum</i> (HAUPT)
<i>Oppelia nimbata</i> STEUER (<i>non</i> OPPEL) 1897, p. 74, pl. VII, figs. 16, 17.	<i>Glochiceras steueri</i> n. sp.
<i>Pseudinvoluticeras decipiens</i> SPATH 1925, p. 124 = <i>S. payeri</i> DOUV. (<i>non</i> TOULA) 1910, p. 18, pl. III, figs. 3a-b	<i>Pseudinvoluticeras douvillei</i> SPATH
<i>Virgatospinctes lotenoensis</i> WEAVER, 1931, p. 423, pl. 48, figs. 322, 323	<i>Pseudinvoluticeras douvillei</i> SPATH
<i>Virgatospinctes erinoides</i> INDANS (<i>non</i> BURCK.) 1954, p. 109, pl. 15, fig. 1	<i>Pseudinvoluticeras douvillei</i> SPATH
<i>Virgatospinctes windhauseni</i> WEAVER, 1931, p. 425, pl. 48, figs. 324, 325	<i>Pseudinvoluticeras windhauseni</i> (WEAV.) n. comb.
<i>Holcodiscus wilfridi</i> DOUV., 1910, p. 12, pl. II, fig. 6	<i>Pseudinvoluticeras</i> (?) <i>wilfridi</i> (DOUV.)
<i>Perispinctes</i> aff. <i>transitorius</i> BURCK. (<i>non</i> OPPEL), 1903, p. 40, pl. V, figs. 4-9	<i>Virgatospinctes evolutus</i> n. sp.
<i>Aulacosphinctes</i> cf. <i>A. transitorius</i> WEAVER (<i>non</i> OPPEL), 1931, p. 415, pl. 45, fig. 306	<i>Virgatospinctes evolutus</i> n. sp.
<i>Perispinctes contiguus</i> BURCK. (<i>non</i> CATULLO), 1903, p. 38, pl. IV, figs. 7-10	<i>Virgatospinctes evolutus</i> n. sp.
<i>Perispinctes choicensis</i> BURCK., 1903, p. 50, pl. VI, figs. 10-12, pl. VIII, fig. 6	<i>Choicensisphinctes choicensis</i> (BURCK.) gen. nov.
<i>Virgatospinctes</i> cf. <i>raja</i> INDANS (<i>non</i> UHLIG), 1954, p. 110, pl. 14, figs. 1-3	<i>Choicensisphinctes choicensis</i> (BURCK.)
<i>Perispinctes erinoides</i> BURCK. 1903, p.	<i>Choicensisphinctes erinoides</i> (BURCK.) n. comb.
<i>Perispinctes</i> aff. <i>erinus</i> BURCK. (<i>non</i> d'ORB.), 1900a, p. 42, pl. XXV, fig. 1	<i>Choicensisphinctes erinoides</i> (BURCK.)
<i>Aulacosphinctes windhauseni</i> WEAVER 1931, p. 412, pl. 44, fig. 300	<i>Subdichotomoceras windhauseni</i> (WEAV.) n. comb.
<i>Oppelia</i> (<i>Neochetoceras</i>) <i>waageni</i> KRANTZ (<i>non</i> ZITTEL), p. 434	? <i>Parastreblites comahuensis</i> n. sp.
<i>Oppelia</i> (<i>Neochetoceras</i>) <i>waageni</i> WEAVER (<i>non</i> ZITTEL), 1931, p. 399	? <i>Parastreblites comahuensis</i> n. sp.

VI. AMMONITE ZONES AND CORRELATIONS

The ammonite fauna of the Vaca Muerta Formation can be grouped into 4 associations which basically correspond to ammonite zones previously established for the Andean Tithonian by other authors (BURCKHARDT, 1900a, 1900b, 1903; WEAVER, 1931; A. F. LEANZA, 1945, 1947; GROEBER, 1946; GROEBER *et al.*, 1952; STIPANTICIC, 1969; H. LEANZA, 1973; H. LEANZA & C. HUGO, 1977). These are the *V. mendozanus* Zone, the *P. zitteli* Zone, the *A. proximus* Zone and the *W. internispinosum* Zone. The first zone is located in the uppermost Lower Tithonian while the remaining three constitute the Middle Tithonian. Upper Tithonian sediments are present in the overlying Picún Leufú Formation, but their coastal facies prevented the establishment of an ammonite fauna. In Cerro Lotena, only *Substeueroceras* has been recorded from this formation (H. LEANZA, 1973).

Data from this and previous studies indicate that the *V. mendozanus* Zone is not a completely satisfactory one. This is because this species is present only in very small numbers within the Neuquén and Mendoza basin, and, moreover, its systematic position is still rather uncertain. Progress has been made, however, in the *W. internispinosum* Zone, where genera which previously were unknown or poorly documented have now been identified and described. In Table II, correlations between Cerro Lotena (Neuquén) and Sierra Azul (Mendoza) are given.

The *Virgatospinectes mendozanus*¹⁾ Zone

This zone was originally established by BURCKHARDT (1900a, p. 82; 1903, p. 106) as those sediments containing numerous *Virgatospinctinae* in the basal portion of the Vaca Muerta Formation, at the beginning of the Tithonian transgression in the Neuquén and

Mendoza basin. The type locality is situated in the region between Cajón del Burro and the Choica River valley at the beginning of the Río Grande, Mendoza province, Argentina. This zone, which is characterized by a notable uniformity throughout the basin, consists of bituminous black shales with common, variably sized calcareous nodules and concretions, which usually contain *Virgatospinctinae*.

On the basis of studies of several sections of the Vaca Muerta Formation in the Neuquén and Mendoza basin, LEANZA & HUGO (1977, p. 250) suggested that the *V. mendozanus* Zone could be revised. This zone, which occurs at the base of the Tithonian transgressive sequence across hundreds of kilometers, frequently lacks *V. mendozanus* itself. In its place, *Choicensisphinctes choicensis* is often present. This species has been recorded in the sections of Cerro Lotena, Picún Leufú, Mallín de los Caballos, Mallín Quemado, Cajón de Almaza, Bardas Blancas and Arroyo Cieneguitas. *V. mendozanus* was found only in the Puerta Curaco section. It is worth noting that although WEAVER (1931) stated that specimens of *V. mendozanus*, particularly in central and southern Neuquén, constituted up to 75 % of this assemblage, he neither illustrated nor described this species. Nevertheless, on the basis of priority, together with the fact that *Ch. choicensis* is an endemic form, the present author favours retention of the original name, though noting the rarity of the species and its somewhat uncertain systematic position.

In Cerro Lotena, the *V. mendozanus* Zone is 25 m thick and contains the following ammonites: *Pseudinvoluticeras douvillei* SPATH, *P. windhauseni* (WEAV.) n. comb., *P. (?) wilfridi* (DOUV.), *Virgatospinectes andesensis* (DOUV.), *V. mexicanus* (BURCK.), *V. denseplicatus rotundus* SPATH, *V. evolutus* n. sp., *V. burckhardti* (DOUV.) *Choicensisphinctes choicensis* (BURCK.),

¹⁾ The history of this species begins with BURCKHARDT (1900a, p. 41, pl. 25, figs. 6-8), who figured some specimens from Portezuelo Montañés as *Perisphinctes* aff. *lothari* CHOFFAT. Three years later, the same author referred to the same specimens as *Virgatites scythicus* VISCHNIKOFF (BURCKHARDT, 1903, p. 45, pl. VII, figs. 1-8) a determination which in this case was supported by PAVLOW. This latter classification was questioned by DOUVILLÉ (1910, p. 7) who, when establishing *Virgatites andesensis* DOUVILLÉ on the basis of material from Neuquén, included *Virgatites scythicus* BURCK. (*non* VISCHNIKOFF) in this species. BURCKHARDT himself (1911a, foot note; 1911b, p. 772) partly accepted the opinion of DOUVILLÉ in the sense that the specimens from Portezuelo Montañés did not correspond to the cited Russian species, but also stated that his *Virgatites scythicus* could be included in the synonymic list of *V. andesensis* DOUVILLÉ. Consequently, BURCKHARDT (1911a, p. 482, foot note) proposed a new name for the specimens of Paso Mantánés — *Virgatites mendozanus* — retaining the

name *V. andesensis* only for the specimens figured by DOUVILLÉ in 1910. A few years later, STEIGER (1914, p. 502) included BURCKHARDT's species in the genus *Perisphinctes*. SPATH (1927-33, p. 527) also commented on this problem, and included the *mendozanus* species of BURCKHARDT in the genus *Dorsoplanites*. However, five years later, after studying it in more detail he stated that the similarity with *Dorsoplanites* is "probably entirely superficial" (SPATH, 1936, p. 72) and "could equally well be included in *Virgatospinectes*" (SPATH, *op. cit.*, p. 29). Recently, R. ENAY (1964, p. 365) included the same species in *Subplanites*. However, the identification of BURCKHARDT's species as belonging to the genus *Virgatospinectes*, as made by WEAVER (1931) SPATH (1936), INDANS (1954) and many others, has gained more widespread popularity. Considering the shortage of material which could throw light on the taxonomic filiation of this enigmatic species, the present author prefers to place it in *Virgatospinectes* retaining in this way the more widely known name.

TABLE II
Ammonite Zones in Cerro Lotena and Sierra Azul

Age		Ammonites Zones	Cerro Lotena (Neuquén)								Sierra Azul (Mendoza)			
V A L A N G I N I A N	U	<i>O. curacoensis</i>												+
	L	<i>N. wichmanni</i>												+
B E R R I A S I A N	U	<i>S. damesi</i>												+
	L	<i>A. noduliferum</i>												+
T I T H O N I A N	U	<i>Ss. koeneni</i>												+
		<i>C. alternans</i>												+
		<i>W. internispinosum</i>						+						+
	M	<i>Au. proximus</i>						+						
		<i>P. zitteli</i>						+						
	L	<i>V. mendozanus</i>						+						

Abbreviations: O = *Olcostephanus*, N = *Neocomites*, S = *Spiticeras*, A = *Argentinceris*, Ss = *Subteueroceras*, C = *Corongoceras*, W = *Windhauseniceras*, Au = *Aulacosphinctes*, P = *Pseudolissoceras*, V = *Virgatosphinctes*, L = Lower, M = Middle, U = Upper.

Ch. choicensis subtilis n. ssp. and *Ch. erinoides* (BURCK.). *V. mendozanus* is absent.

On the basis of the studies of BURCKHARDT (1900a, 1900b, 1903), HAUPT (1907), KRANTZ (1926, 1928), WEAVER (1931) and INDANS (1954) this zone is placed in the Lower Tithonian. This assignment is confirmed in the case of Cerro Lotena by the presence of the genus *Pseudinvoluticeras*, common in sediments of Lower Tithonian age in Somaliland (SPATH, 1925), Madagascar (COLLIGNON, 1960) and Mexico (VERMA & WESTERMANN, 1973). ZEISS (1968) has correlated this zone with the uppermost Lower Tithonian *Parapallasiceras palatinum* Zone of the Franconia region.

The *Pseudolissoceras zitteli* Zone

This zone, which overlies the *V. mendozanus* Zone in the region situated between Cajón del Burro and the Choica River valley, was proposed by BURCKHARDT (1900a, p. 83; 1903, p. 107). It has a wide distribution throughout the whole Neuquén and Mendoza basin (cf. LEANZA & HUGO, 1977). In Cerro Lotena, the *P. zitteli* Zone is 26 m thick and contains numerous variably sized specimens of *P. zitteli*, in association with limited numbers of *P. pseudoolithicum* (HAUPT), *Glochiceras steueri* n. sp., *Hildoglochiceras wiedmanni* n. sp. and *Parastreblites comabuensis* n. sp. Also present are abundant *Laevaptychus* (cf. CLOSS, 1961a, b) and vertebrate bones and fish scales (see WINDHAUSEN, 1914).

In the chapters dealing with faunal analysis and systematic descriptions, data are given on the distribution of the genus *Pseudolissoceras* and its species. On the basis of the studies by HAUPT (1907), KRANTZ (1926, 1928), WEAVER (1931), H. GERTH (1935), GROEBER (1946), GROEBER *et al.* (1952), STIPANICIC (1969), H. LEANZA (1973), and LEANZA & HUGO (1977), the age of the *P. zitteli* Zone can be taken as the lowermost Middle Tithonian, although the presence of the new haploceratids described in this report suggests a slightly older age. Considering the uppermost Lower Tithonian age of the underlying ammonite zone, the *P. zitteli* Zone is placed in the lowermost Middle Tithonian. The same age for the genus *Pseudolissoceras* had been suggested by BARTHEL (1962) and ZEISS (1968). The record of *P. zitteli* by ARNOULD-SAGET (1951, 1951a) in the Upper Tithonian of Tunisia does not seem to be concordant with its known stratigraphic distribution. If the bipartite division of the Tithonian stage is used, the *P. zitteli* Zone would fall into the Lower Tithonian (cf. R. ENAY, 1964, 1972, 1973; J. WIEDMANN, 1968; VERMA & WESTERMANN, 1973).

The *Aulacosphinctes proximus* Zone

This zone is equivalent to the *Aulacosphinctes colubrinoides* Zone proposed by BURCKHARDT (1900a, p. 84; 1903, p. 108), and overlies the *P. zitteli* Zone. Following the works from GROEBER (1946) and

GROEBER *et al.* (1952), the *A. colubrinoides* Zone was renamed as the *A. proximus* Zone, a name which was later accepted by STIPANICIC (1969), H. LEANZA (1973) and LEANZA & HUGO (1977). This is the most poorly defined zone in the Andean Tithonian because, excluding *Subdichotomoceras*, *Aspidoceras* and *Pseudhimalayites* it contains no other ammonite genera. Moreover, many species of *Aulacosphinctes* range throughout almost the whole Tithonian Stage. However, the vertical extent of the *A. proximus* Zone can be defined if it is considered as the interval that has as its base the last representatives of *P. zitteli*, and as its top the first occurrence of the species *W. internispinosum*. So defined, this zone at Cerro Lotena is 21 m thick, and in addition to numerous specimens of *A. proximus*, contains *Subdichotomoceras* sp. juv. indet., *Laevaptychus crassissimus* (HAUPT), *Aspidoceras andinum* (STEUER), *A. neuquensis* (WEAV.), and *Pseudhimalayites steinmanni* (STEUER).

The *A. proximus* Zone has also been identified in the Chilean part of the Andean geosyncline (CORVALÁN & PEREZ, 1958; CORVALÁN, 1959). As it occurs between the *P. zitteli* and *W. internispinosum* Zones, its age accordingly falls into the middle part of the Middle Tithonian.

The *Windhausenicerias internispinosum* Zone

This zone was originally proposed by WEAVER (1931, p. 46), who placed it in the Upper Tithonian *sensu lato*. Later, A. F. LEANZA (1945, table *hors de text*) placed this zone in the lowermost Upper Tithonian, noting that only *Widmannicerias mirum* occurred in association with the index species. ARKELL (1956, p. 582), who considered this zone uncorrelatable with those of the European Upper Tithonian, placed it in the Middle Tithonian.

Though *W. internispinosum* is an entirely endemic form, it is very abundant at Cerro Lotena in the upper part of the Vaca Muerta Formation. In this zone, ammonites have been found which were previously unknown or poorly documented in the Andean domain, but which now allow its age to be more precisely determined. The zone is 38 m thick and contains the following ammonites: *Windhausenicerias internispinosum* (KRANTZ), *Hemispiticeras* aff. *H. steinmanni* (STEUER), *Pachysphinctes americanensis* n. sp., *Corongoceras lotenoense* SPATH, *Subdichotomoceras windhauseni* (WEAV.), *S. araucanense* n. sp., *Aulacosphinctoides* aff. *A. bundesianus* (UHLIG), *A.* sp. indet., *Parapallasiceras* aff. *P. pseudocolubrinoides* OLORIZ, *P.* aff. *recticosta* OLORIZ, *P.* sp. indet. and *Aspidoceras euomphalum* STEUER.

Assemblages containing *Subdichotomoceras*, *Pachysphinctes*, *Aulacosphinctoides* and *Aspidoceras* have been reported from the Middle Katrol beds of Cutch, which ARKELL (1956, p. 388) refers to the Middle Kimmeridgian with interrogant. In the Tendaguru Group

of east Africa, *Subdichotomoceras* and *Pachysphinctes* have also been found together, and were referred by ARKELL (1956, p. 335) to the uppermost Kimmeridgian. Considering the equivalence of the Middle and Upper Kimmeridgian to the Lower and Middle Tithonian, and taking into account the stratigraphic position of the *W. internispinosum* Zone, it is accordingly placed more properly in the Middle Tithonian than in the Upper Tithonian. Moreover, the genus *Parapallasiceras*, which is also present in Cerro Lotena, apparently never crosses into levels younger than the Middle Tithonian (cf. ZEISS, 1968). Although the genus *Corongoceras* is common in the Andean Upper Tithonian (cf. A. F. LEANZA, 1945), *C. lotenoense* SPATH appears to occur in the Neuquén basin at somewhat lower levels (cf. H. LEANZA, 1973, p. 116; 1975, p. 583). On the basis of these reasons, the *W. internispinosum* Zone is placed in the uppermost Middle Tithonian, and is probably equivalent to the *Burckhardticer* Zone in the Betic ranges of southern Spain (cf. OLORIZ, 1978).

The Upper Tithonian of the Andean domain therefore is entirely represented by the *Corongoceras alternans* and *Substeuero* *ceras koeneni* Zones. The first zone, proposed by A. F. LEANZA (1945), appears immediately above the *W. internispinosum* Zone and probably is equivalent to the *Berriasella delphinensis* Zone of southeast France, and to the lower part of the "*Virgatosphinctes*" *transitorius* Zone of the Alpine region (cf. ENAY, 1964). The *Substeuero* *ceras koeneni* Zone is equivalent to the *Berriasella chaperi* Zone of southeast France and to the upper part of the "*Virgatosphinctes*" *transitorius* Zone of the Alpine region. Therefore, the *C. alternans* and *S. koeneni* Zones can easily be correlated with the European Ardesian.

As noted above, the Upper Tithonian is represented at Cerro Lotena in the overlying Picún Leufú Formation. However, this formation lacks the ammonites so common in more pelagic facies, such as in the Sierra Azul in the southern part of Mendoza. In Table III the ammonite zonation of the Andean Tithonian is given.

TABLE III
Ammonite Zonation of the Andean Tithonian

Age	Ammonite Zones	Fossils
U P P	SUBSTEUEROCERAS KOENENI	<i>Aulacosphinctes azulensis</i> LEANZA, <i>A. mangaensis</i> (STEUER), <i>Pectinatites</i> (?) <i>striolatus</i> (STEUER), <i>Berriasella fraudans inflata</i> LEANZA, <i>B. inaequicostata</i> GERTH, <i>Parodontoceras calistoides</i> (BEHR.), <i>Aspidoceras longaeuum</i> LEANZA, <i>Substeuero</i> <i>ceras exstans</i> LEANZA, <i>Blanfordiceras vetustum</i> (STEUER), <i>Himalayites andinus</i> H. LEANZA, <i>Spiticeras acutum</i> GERTH.
	T E	
	R I	CORONGOCERAS ALTERNANS
T H O N D I L A N	WINDHAUSENICERAS INTERNISPINOSUM	<i>Pachysphinctes americanensis</i> H. LEANZA, <i>Hemispiticeras</i> aff. <i>H. steinmanni</i> (STEUER), <i>Subdichotomoceras araucanense</i> H. LEANZA, <i>S. windhauseni</i> (WEAV.), <i>Parapallasiceras</i> aff. <i>pseudocolubrinooides</i> OLORIZ, <i>P.</i> aff. <i>P. recticosta</i> OLORIZ, <i>P.</i> sp. indet., <i>Aulacosphinctoides</i> aff. <i>A. hundesianus</i> (UHLIG), <i>Aspidoceras euomphalum</i> STEUER, <i>Corongoceras lotenoense</i> SPATH.
	AULACOSPHINCTES PROXIMUS	<i>Subdichotomoceras</i> sp. juv. indet. <i>Pseudhimalayites steinmanni</i> (STEUER), <i>Aspidoceras andinum</i> STEUER, <i>A. neuquensis</i> WEAV., <i>Laevaptychus crassissimus</i> (HAUPT).
	PSEUDOLISSOCERAS ZITTELI	<i>Pseudolissoceras pseudooolithicum</i> (HAUPT), <i>Glochiceras steueri</i> H. LEANZA, <i>Hildoglochiceras wiedmanni</i> H. LEANZA, <i>Parastreblites comabuensis</i> H. LEANZA.
L O W E R	VIRGATOSPHINCTES MENDOZANUS	<i>Pseudinvoluticeras douvillei</i> SPATH, <i>P. windhauseni</i> (WEAV.), <i>P. (?) wilfridi</i> (DOUV.), <i>Choicensisphinctes choicensis</i> (BURCK.), <i>Ch. choicensis</i> <i>sutilis</i> H. LEANZA, <i>Ch. erinoides</i> (BURCK.), <i>Virgatosphinctes andensis</i> (DOUV.), <i>V. mexicanus</i> (BURCK.), <i>V. burckhardti</i> (DOUV.), <i>V. densplicatus rotundus</i> SPATH, <i>V. evolutus</i> H. LEANZA, <i>Subplanites margüensis</i> SPATH.

VII. SYSTEMATIC DESCRIPTIONS

Measurements and abbreviations

All measurements are in millimeters and include the ornament. With rare exceptions they are taken on the internal mold. The abbreviations employed in the systematic descriptions are as follows:

- D = maximum diameter at a given growth stage
 U = diameter of umbilicus measured at seam
 H = height of the whorl measured in the plane of coiling
 W = maximum width of whorl at right angles to the plane of coiling

In most cases, measurements are given only for the figured and better preserved specimens.

The suture line abbreviations are the following:

- E = external lobe
 L = lateral lobe
 U = umbilical lobe

Repositories

All specimens studied in this report are deposited at the Geological Survey of Argentina (Servicio Geológico Nacional, República Argentina), with the exception of 3 specimens from the F. von Huene collection at the University of Tübingen, Germany.

The following abbreviations are employed:

- S.G.N. = Servicio Geológico Nacional, República Argentina.
 G.P.I.T. = Institut und Museum für Geologie und Paläontologie Tübingen, Germany.

Gypsum copies of the specimens figured in this report are also deposited at the Tübingen Institute.

Order AMMONOIDEA ZITTEL, 1884

Suborder AMMONITINA HYATT, 1889

Superfamily HAPLOCERATACEAE ZITTEL, 1884

Family HAPLOCERATIDAE ZITTEL, 1884

Genus PSEUDOLISSOCERAS SPATH, 1925

Type species. — *Neumayria zitteli* BURCKHARDT, 1903, p. 55, pl. 10, figs. 1, 2. SD ROMAN, 1938, p. 176.

In the genus *Pseudolissoceras* two groups with distinctive characteristics can be clearly distinguished: the *Pseudolissoceras zitteli* group and the *Pseudolissoceras rasile* group.

Both groups have in common a characteristic suture line, with E and L wide but not deep; both the width and depth of the E/U saddle equivalent to almost half of the E/L saddle. The second lateral saddle (E/U) is diagnostic and clearly differs from that of

the genus *Haploceras* ZITTEL, 1870 (type species: *Ammonites elimatus* OPPEL, in ZITTEL, 1868, pl. 13, (figs. 1a—c, SD SPATH, 1923) which displays an E/U saddle larger and higher than the E/L saddle (cf. SCHINDEWOLF, 1963, p. 379, text fig. 208).

The group of *P. zitteli* (BURCKHARDT, 1903, p. 55, pl. 10, figs. 1—8) is characterized by very involute shells (U/D = 0.18 to 0.26), ornamentation with fine falcoidal striae, whorl sections higher than wide, and sharp umbilical borders. The following species have been placed in this group: *P. zitteli* (HAUPT, 1907, pl. 7, figs. 3a, b; 4a, c), *P. zitteli* (KRANTZ, 1928, pl. 1, fig. 6), *P. zitteli* (WEAVER, 1931, pl. 43, fig. 291), *P. cf. zitteli* (IMLAY, 1942, pl. 4, figs. 1, 3, 4, 7, 8, 11, 12), *P. zitteli* (OLORIZ, 1978, pl. 2, fig. 12, text fig. 43), *P. advena* (SPATH, 1950, pl. 6, figs. 9—10), *P. concorsi* (DONZE & ENAY, 1961, pl. 1, fig. 1, text fig. 4), *P. bavariicum* (BARTHEL, 1962, pl. 2, figs. 7—9) and *P. zitteli* (VERMA & WESTERMANN, 1973, pl. 26, figs. 3—5, text figs. 12—13).

The group of *P. rasile* (OPPEL, 1865, p. 549; in ZITTEL, 1870, p. 55, pl. 4, figs. 2, 3) is characterized by more evolute whorls (U/D = 0.22 to 0.36), smooth tests, somewhat inflated shells, whorl sections almost as wide as high, and the absence of sharp umbilical borders. This group differs from *Haploceras* only in its suture line (cf. *supra*); the morphology of the shells is almost identical. The following species have been placed in this group: *P. rasile inflatum* (ZITTEL, 1870, pl. 4, figs. 2), *P. rasile planiusculum* (ZITTEL, 1870, pl. 4, figs. 3a—c) which was reported by BEHRENDSEN (1892, p. 388) from Rodeo Viejo and Malargüe (Mendoza, Argentina), *P. planiusculum* (AVRAM, 1976, pl. 7, figs. 5a, b; pl. 8, figs. 2a, b, text fig. 10a—c), *P. subrasile* (BURCKHARDT, 1906, pl. 34, figs. 8—11) and *P. pseudoolithicum* (HAUPT, 1907, pl. 8, figs. 2a—c). It is possible that *P. zitteli* of ARNOULD-SAGET (1951, pl. 1, figs. 12—14, 16) also belongs to this group (see BARTHEL, 1962, p. 14).

In the Cerro Lotena section, 55 specimens attributed to *P. zitteli* have been found; only 3 specimens have been identified as *P. pseudoolithicum*.

Pseudolissoceras zitteli (BURCKHARDT, 1903)
 Pl. 1, Figs. 1a—b, 2a—b, Text-Figs. 2a and 3.

- 1903 *Neumayria Zitteli* BURCKHARDT, p. 55, pl. 10, figs. 1-8.
 1907 *Neumayria Zitteli* BURCKHARDT — HAUPT, p. 200, pl. 7, figs. 3a-b, 4a-c.
 1925 *Pseudolissoceras zitteli* (BURCKHARDT) — SPATH, p. 113 (Gen. nov.).
 1926 *Haploceras (Pseudolissoceras) Zitteli* (BURCKHARDT) — KRANTZ, p. 436, pl. 17, figs. 4, 5.

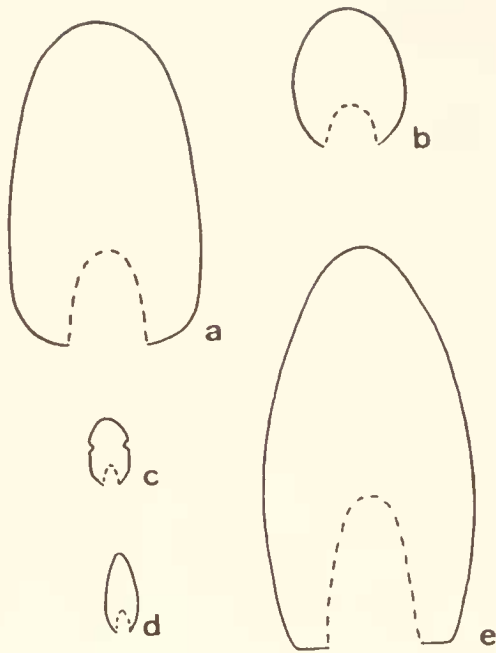


Figure 2: Whorl sections of Haploceratidae and Oppeliidae. a: *Pseudolissoceras zitteli*, S.G.N. 8887/1; b: *P. pseudooolithicum*, S.G.N. 7327/1; c: *Hildogloebiceras wiedmanni* n. sp., G.P.I.T. 1545/1 (Holotype); d: *Gloebiceras steueri* n. sp., S.G.N. 7333/5 (Paratype); e: *Parastreblites comabuensis* n. sp., S.G.N. 7326. (Holotype). Natural size.

- 1928 *Haploceras (Pseudolissoceras) Zitteli* (BURCKHARDT) — KRANTZ, p. 18, pl. 1, fig. 6.
 1931 *Pseudolissoceras zitteli* (BURCKHARDT) — WEAVER, p. 401, pl. 43, fig. 291.
 1938 *Haploceras (Pseudolissoceras) Zitteli* (BURCKHARDT) — ROMAN, p. 176, pl. 16, fig. 170 (Reproduction of BURCKHARDT's original: pl. 10, figs. 1, 2; 1903).
 1942 *Pseudolissoceras* cf. *P. zitteli* (BURCKHARDT) — IMLAY, p. 1443, pl. 4, figs. 1, 3, 4, 7, 8, 11, 12.
 1950 *Pseudolissoceras zitteli* (BURCKHARDT) — SPATH, p. 101, pl. 6, figs. 8a-c.
 1973 *Pseudolissoceras zitteli* (BURCKHARDT) — VERMA & WESTERMANN, p. 168, pl. 26, figs. 3-5, text figs. 12-13.
 1978 *Pseudolissoceras zitteli* (BURCKHARDT) — OLORIZ, p. 34, pl. 2, fig. 12, text fig. 43.

Material. — 55 specimens, mostly well preserved. S.G.N. 7325/1—2; S. G. N. 7331/1—4, 6; S.G.N. 7333/1—4; S.G.N. 7334/1—4; S.G.N. 8887/1—2; S.G.N. 8897/1; S.G.N. 8920/1—4; S.G.N. 8938/1—3; S.G.N. 8925/1—21; S.G.N. 8926/1—9. The specimens illustrated in plate 1, figs. 1a—b and 2a—b, correspond respectively to numbers S.G.N. 7325/1 and S.G.N. 7333/1.

Description. — The largest specimen has a diameter of 124 mm (S.G.N. 7334/1) and the smallest a diameter of only 12.8 mm (S. G. N. 1925/14). The diameters of the remaining samples transitionally cover the range between these extremes. The shell is involute. On the average, the umbilicus of the smaller specimens occupies 18 % of the shell diameter, and up to 26 % in the larger specimens. The most extreme ratios were measured in specimens S.G.N. 7333/1 ($U/D = 0.13$) and S.G.N. 7334/1 ($U/D = 0.27$). This latter ratio belongs to the specimen of maximum size (diameter = 124 mm). These data clearly show the tendency for the shell to become more evolute with age.

Whorl sections are higher than wide (text-fig. 2a). Umbilical borders become sharper with increase in shell size: smaller specimens show rounded umbilical borders, while larger ones exhibit an umbilical slope which is strongly inclined and sometimes almost vertical. The flanks are gently convex and the periphery slightly rounded. In some specimens whose tests have been preserved it is possible to observe very fine somewhat falconid striae.

The suture line (text-fig. 3) coincides exactly with that originally described by BURCKHARDT (1903, p. 55). The E/L saddle is wide and is divided by an accessory lobe in two asymmetrical parts. The L lobe is very shallow and somewhat less wide than E/L. The E/U saddle has a width almost equivalent to half the E/L saddle, and also is divided by a small lobe into two asymmetrical parts. There are also two U lobes (U_2 and U_3) which are not very elaborate.

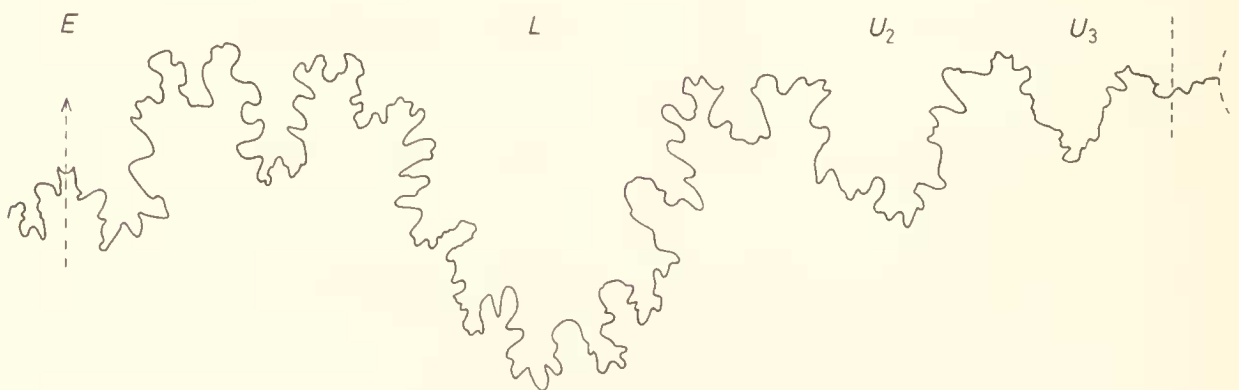


Figure 3: Suture line of *Pseudolissoceras zitteli* (BURCK.), S.G.N. 7325/1. $\times 3$.

Measurements (better-preserved specimens only)

Specimen	n°	D	U	U/D	H	W	H/W
S.G.N.	7325/1	94	25	0.26	40	26	1.53
S.G.N.	7325/2	51	12	0.23	23	14	1.64
S.G.N.	7331/1	117	29	0.24	42	27	1.55
S.G.N.	7331/2	69	12	0.17	33	19	1.73
S.G.N.	7331/3	46	8	0.17	24	12	2.00
S.G.N.	7331/4	81	17	0.20	37	24	1.54
S.G.N.	7331/6	14	3	0.21	7	5	1.40
S.G.N.	7333/1	51	7	0.13	28	15	1.86
S.G.N.	7333/2	41	9	0.21	22	12	1.83
S.G.N.	7333/3	32	8	0.25	19	12	1.58
S.G.N.	7333/4	38	10	0.26	20	12	1.66
S.G.N.	7334/1	124	34	0.27	51	35	1.45
S.G.N.	7334/2	53	9	0.16	29	15	1.93
S.G.N.	7334/3	58	10	0.17	29	14	2.07
S.G.N.	8920/1	53	10	0.18	29	16	1.81
S.G.N.	8920/2	44	7	0.15	23	13	1.76
S.G.N.	8920/4	45	10	0.22	21	15	1.40
S.G.N.	8887/1	97	23	0.23	42	25	1.68
S.G.N.	8897/3	33	7	0.21	18	12	1.50
S.G.N.	8926/1	43	9	0.20	26	15	1.73
S.G.N.	8926/2	37	8	0.21	18	12	1.50
S.G.N.	8926/3	31	7	0.22	17	11	1.54
S.G.N.	8926/4	31	6	0.19	17	10	1.70
S.G.N.	8926/5	25	5	0.20	14	10	1.40
S.G.N.	8926/6	28	5	0.17	16	10	1.60
S.G.N.	8926/7	23	4	0.17	13	9	1.44
S.G.N.	8926/8	21	3.5	0.16	11.5	7.5	1.53
S.G.N.	8926/9	17	4	0.23	7	5.5	1.27
S.G.N.	8925/2	37	7	0.18	20	12	1.66
S.G.N.	8925/3	34	7	0.20	18	10	1.80
S.G.N.	8925/4	26	6	0.23	13	9	1.44
S.G.N.	8925/5	23	5.5	0.23	12	9	1.33
S.G.N.	8925/6	19	4	0.21	11	7.5	1.46
S.G.N.	8925/7	18	3.5	0.19	10	7	1.42
S.G.N.	8925/8	17.5	3	0.17	10	6.5	1.53
S.G.N.	8925/9	16	4	0.25	8	5.5	1.45
S.G.N.	8925/10	17.5	3.5	0.20	8	5.5	1.45
S.G.N.	8925/11	15.5	3	0.19	8	5	1.60
S.G.N.	8925/12	15	3	0.20	9	6	1.50
S.G.N.	8925/13	17	3.1	0.18	8	5	1.60
S.G.N.	8925/14	12.8	2.5	0.19	7	4.8	1.45

Remarks. — The described specimens can be readily placed in the genus *Pseudolissoceras* SPATH (1925, p. 113); specifically they correspond to *P. zitteli* (BURCKHARDT, 1903). The specimens illustrated by HAUPT (1907), KRANTZ (1926, 1928) and WEAVER (1931) were also found in Cerro Lotena. Some authors have suggested that this species displays sexual dimorphism (cf. VERMA & WESTERMANN, 1973, p. 145), but the present study reveals that most of the smaller specimens (up to 23 mm diameter) belong to immature specimens which could have attained a greater size.

No specimens have been found with the whorl sec-

tion as figured by HAUPT (1907, pl. 7, fig. 4b). It is possible that this whorl section is from an unusually crushed specimen and does not constitute a variety of *P. zitteli*, as was suggested by BARTHEL (1962, p. 13, 15). It does, however, resemble the whorl section of *P. concorsi* DONZE & ENAY (1961, p. 46).

The inclusion of "*Neumayria*" *subbrasilis* BURCKHARDT (1906, p. 127, pl. 34, figs. 8—11) in the synonymic list of *P. zitteli* by VERMA & WESTERMANN (1973, p. 168) appears to be inadequate because the umbilicus occupies 36% of the diameter of the shell (U/D = 0.36) and the whorls are only slightly higher than wide (H/W = 1.14). These features suggest that BURCKHARDT's species is related to the *P. rasile* group (cf. supra). The cited ratios are much more anomalous for the *P. zitteli* group because "*N.*" *subbrasilis* has only an 18 mm diameter; for this size, the average U/D ratio of the *P. zitteli* group does not exceed 26% of the shell diameter.

Occurrence. — *P. zitteli* occurs in beds 3, 4, 5 and 6 of the Cerro Lotena section, in association with *P. pseudoolithicum*, *Glodicerias steueri* n. sp., *Parastreblites comahuensis* n. sp. and *Hildoglochicerias wiedmanni* n. sp. The first specimens of *P. zitteli* occur 25 m above the basal conglomerate of the Vaca Muerta Formation.

Age. — Lowermost Middle Tithonian. *P. zitteli* Zone.

Pseudolissoceras pseudoolithicum (HAUPT, 1907)

Pl. 1, Figs. 5a—b; Text-Figs. 2b and 4.

1903 *Neumayria pseudoolithica* HAUPT, p. 200, pl. 8, figs. 2a-c.

1926 *Pseudolissoceras pseudoolithicum* (HAUPT) — KRANTZ, p. 435 (n. comb.)

1931 *Pseudolissoceras pseudoolithica* (HAUPT) — WEAVER, p. 400.

? 1951 *Pseudolissoceras zitteli* (BURCK.) — ARNOULD-SAGET, p. 9, pl. 1, figs. 12a-c, 13a-c, 14 and 16a-c.

Material. — Three well-preserved specimens. S.G.N. 7328/1 (Figured in Pl. 1, Figs. 5a—b); S.G.N. 7328/2 and S.G.N. 7331/5.

Description. — Small shell, moderately evolute, with suboval whorl section, only very slightly higher than wide (text-fig. 2b). U/D = 0.26 to 0.27. The umbilical slope is strongly inclined but passes transitionally into the flanks forming an rounded umbilical border. In contrast to *P. zitteli* an umbilical edge never exists. The flanks are clearly convex and the periphery is rounded. The suture line (text-fig. 4) strongly resembles that of *P. zitteli*, and is characterized by a wide E/L saddle divided by a small accessory lobe in two asymmetrical parts. The L lobe is wide and shallow and the E/U saddle has a width equivalent to half of E/L. The U lobes are very simple and not oblique.

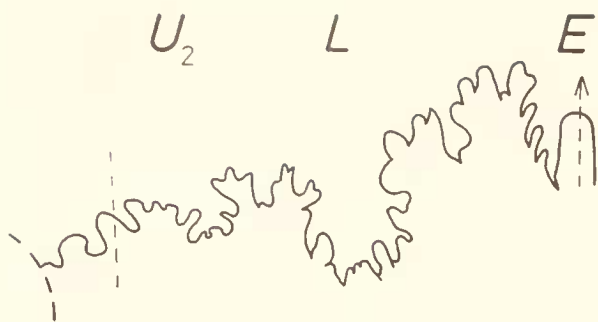


Figure 4: Suture line of *Pseudolissoceras pseudoolithicum* (HAUPT), S.G.N. 7328/2. $\times 6$.

Measurements. —

Specimen	n°	D	U	U/D	H	W	H/W
S.G.N.	7328/1	38	10	0.26	18.5	16	1.15
S.G.N.	7328/2	22	6	0.27	12	11	1.09
S.G.N.	7331/5	21	5.5	0.26	11	10	1.10

Remarks. — The described specimens closely resemble *P. pseudoolithicum* (HAUPT, 1907, p. 200, pl. 8, figs. 2a—c) which, as previously mentioned, is included in the *P. rasile* group. The shell morphology of *P. pseudoolithicum* strongly resembles that of *Haploceras elimatum* (OPPEL, 1865, ZITTEL, 1870), which is the type species of *Haploceras* by the subsequent designation of SPATH (1923); however, it differs in having a suture line with a E/U saddle as wide as the E/L saddle and also clearly more elevated. By contrast, HAUPT's species displays a smaller and more depressed E/U, similar to that of *P. zitteli*. For this reason the present author retains HAUPT's species in the genus *Pseudolissoceras*. Acquisition of better material may, however, eventually allow establishment of a new genus.

It is very probable that "*P. zitteli*" of ARNOULD-SAGET (1951, p. 9, pl. 1, figs. 12a—c, 13a—c, 14 and 16a—c) from Tunisia, on the basis of whorl shape, dimensions and suture, could also belong to the species here described.

It is worth remarking that HAUPT (1907, p. 200) gives an umbilicus diameter of 13.5 mm for the specimen figured in pl. 8, fig. 2a. This specimen, as can be seen, is only 8 mm in diameter, with the other dimensions as stated by HAUPT. Consequently, the U/D ratio for this specimen is 0.25 and not 0.43, which agrees very well with the described material.

Occurrence. — Bed 6 of the Cerro Lotena section, in association with *P. zitteli*.

Age. — Lowermost Middle Tithonian. *P. zitteli* Zone.

Genus GLOCHICERAS HYATT, 1900

Type species. — *Ammonites nimbatus* OPPEL, 1863, p. 191, pl. 52, figs. 5a, b.

Glochiceras steueri n. sp.

Pl. 1, Figs. 3a—b, Text-Fig. 2d.

Holotype. — *Oppelia nimbata* STEUER (non OPPEL), 1897, p. 74, pl. 7, fig. 17.

Paratypes. — *Oppelia nimbata* STEUER (non OPPEL), 1897, p. 74, pl. 7, fig. 16 and specimen S.G.N. 7333/5, illustrated in Pl. 1, Figs. 3a—b of this paper.

Locus typicus. — Arroyo Cieneguitas, near its junction with the Salado river, southern Mendoza, Argentina.

Stratum typicum. — Lower part of the Vaca Muerta Formation, in the *P. zitteli* Zone.

Derivatio nominis. — In honour of Doctor Alfred STEUER, who described this species.

Diagnosis. — Small shell, involute and compressed. Ornamentation characterized by fine striae which form, in the internal part of the flanks, a lateral linguiform band projecting towards the aperture. This band is narrow and crenulate, and does not constitute a true sulcus.

Material. — Only one specimen, complete, but with aperture not preserved and umbilicus not very clear. S.G.N. 7333/5. The shell is somewhat crushed.

Description. — Small involute shell, with a U/D ratio = 0.26. Whorl section somewhat subelliptical, higher than wide (text-fig. 2d). Umbilical border gently rounded. Surface of the flanks slightly convex. Periphery gently rounded. Ornamentation characterized by fine striae which commence in the umbilical slope and form a biconvex parabola over the flanks. In the internal portion of the flanks, near the umbilical border, the striae form a small and narrow linguiform band, which is strongly directed towards the aperture. Contiguous bundles of weak striae produce depressions, while bundles of strong striae form elevated folds. As a result, in the lateral linguiform band, folds and depressions alternate throughout the test. Neither the aperture nor the suture line could be observed.

Measurements. — (in mm)

Specimen	n°	D	U	U/D	H	W	H/W
S.G.N.	7333/5	23	6	0.26	11	5?	2.2?

Remarks. — Though the lappets of the specimen are not preserved, it is nevertheless possible, on the basis of whorl shape and ornamentation, to include it in the genus *Glochiceras* HYATT, 1900 (type species:

Ammonites nimbatus OPPEL, 1863, p. 191, pl. 52, figs. 5a, b). The genus *Hildoglochiceras* SPATH, 1924 (type species: *Hecticoceras latistrigatum* UHLIG, 1903, p. 27, pl. 2, figs. 4a, c; pl. 3, fig. 5) is much more evolute and exhibits a deep lateral groove and, as well, subplanate flanks. "*Paraglochiceras*" COLLIGNON, 1960 (type species not designated) does not have a deep lateral groove, but has a whorl shape more evolute and inflated than the true *Glochiceras*.

Specifically, the specimen appears to be identical to *Oppelia nimbata* STEUER (non OPPEL) (1897, p. 74, pl. 7, figs. 16 and 17) from Arroyo Cieneguitas, Mendoza, Argentina. However, this species differs from the genotype, *G. nimbatum* (OPPEL, op. cit.), as its shell is much more compressed, and the strongly crenulate lateral bands are in a position nearer to the umbilical border. For these reasons, it is proposed to designate the specimen as *G. steueri* n. sp., with *Oppelia nimbata* STEUER, 1897, non OPPEL, 1863, as type species.

G. steueri n. sp. has closer affinities with the group of *G. fialar* BURCKHARDT (non OPPEL) (1906, p. 77, pl. 19, figs. 1—19; pl. 20, figs. 6, 12, 14, 15) from Mazapil, Mexico, but differs from these forms in having a more compressed and involute shell. The authentic *G. fialar* (OPPEL, 1863, p. 205, pl. 53, figs. 6a—c) differs from *G. steueri* in being more evolute and in displaying small crenulations around the periphery. *G. angustumbricatum* IMLAY (1939, p. 26, pl. 7, figs. 4—6), although bearing some similarities, clearly differs in having a distinct umbilical border and a strongly inclined umbilical slope. *G. somalicum* SPATH (1925, p. 114, pl. 16, fig. 7) is also more evolute and has a distinct umbilical border and wider lateral band. Finally, *G. parabolistriatum* KRANTZ (1926, p. 434, pl. 15, figs. 3, 4) from Arroyo Loncoche, Mendoza, Argentina, has a more inflated shell, with whorls wider than high, and also a much wider lateral band.

Occurrence. — Lower part of the Vaca Muerta Formation. Bed 3 of the Cerro Lotena section, in association with *P. zitteli* and *H. wiedmanni*.

Age. — Lowermost Middle Tithonian. *P. zitteli* Zone.

Genus HILDOGLOCHICERAS SPATH, 1924

Type species. — *Hecticoceras latistrigatum* UHLIG, 1903, p. 27, pl. 2, fig. 4a—e; pl. 3, fig. 5.

Hildoglochiceras wiedmanni n. sp.

Pl. 1, Figs. 4a—b; Text-Figs. 2c and 5.

Holotype. — *H. wiedmanni* H. LEANZA n. sp., figured in Pl. 1, Figs. 4a—b. G.P.I.T. 1545/1.

Locus typicus. — Cerro Lotena, Neuquén province, Argentina.

Stratum typicum. — Lower part of the Vaca Muerta Formation.

Derivatio nominis. — In honour to the outstanding ammonitologist, Prof. Dr. Jost WIEDMANN, University of Tübingen, Germany.

Diagnosis. — Small shell, strongly evolute. Whorl section somewhat compressed. Subplanate flanks. Rounded umbilical border and convex periphery. Ornamentation smooth, with the presence of a lateral groove in the upper third of the flanks. Somewhat below the groove there is a linguiform parabola directed towards the aperture. Suture line simple, with the E/L saddle very wide and the L lobe narrow and deep.

Material. — One complete specimen, very well preserved. Almost half of the last whorl belongs to the body chamber. G.P.I.T. 1545/1.

Description. — Small evolute shell, with umbilicus wide and shallow. U/D ratio = 0.40. Whorl section somewhat compressed, subrectangular in shape, with rounded borders (text-fig. 2c). Umbilical slope gently inclined. Subplanate flanks and rounded periphery. Ornamentation characterized by a nitid and narrow groove in the upper third of the flanks. In addition, very fine striae form a biconvex parabola, producing in the middle part of the flank, just below the groove, a linguiform process which projects towards the aperture.

The suture line (text-fig. 5) is very simple, with the E/L saddle very wide and the L lobe narrow and deep; very poorly-developed accessory elements.

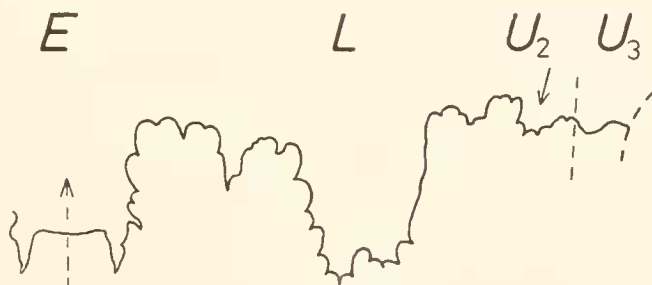


Figure 5: Suture line of *Hildoglochiceras wiedmanni* n. sp., G.P.I.T. 1545/1. $\times 6$.

Measurements. —

Specimen	n°	D	U	U/D	H	W	H/W
G.P.I.T.	1545/1	22	9	0.40	9	6	1.5

Remarks. — The evolute shell with subplanate flanks and the presence of the characteristic lateral groove allow assignment of the specimen to the genus *Hildoglochiceras* SPATH, 1924 (type species: *Hecticoceras latistrigatum* UHLIG, 1903, p. 27, pl. 2, figs. 4a—e; pl. 3, fig. 5). Originally, the specimen was catalogued in the collections of the University of Tübingen as *Haploceras* n. sp. aff. *tenuifalcatum*, a species described more than 100 years ago by NEUMAYR (1873, p. 162, pl. 31, figs. 6a—b) from the *Aspidoceras acanthicum* Zone. However, this classification does not appear to be correct as NEUMAYR's species does not have the lateral groove on the flanks. Instead, the specimen is more similar to *Haploceras* cf. *tenuifalcatum* HAUPT (non NEUMAYR) (1907, p. 201) from Cerro Lotena, which bears lateral grooves. HAUPT compared his material with *Ammonites lingulatus* QUENSTEDT (1858), which is actually included in *Glochiceras* (cf. ZIEGLER, 1958). However, the classification of this ammonite in either *Glochiceras* or *Haploceras* does not appear to be correct because the first genus has a completely smooth test, without ornamentation, while the second one is always much more involute. For these reasons, the specimen is placed in *Hildoglochiceras*. Specifically, the closest form is *H. tenuicostulatum* COLLIGNON (1960, pl. 145, fig. 568, 569) from Madagascar, but this species is more involute and shows some ribbing in the upper part of the flanks. With respect to the other known species of *Hildoglochiceras*, the differences are still more obvious. For this reason, the specimen is considered as a new species named *H. wiedmanni* n. sp.

Occurrence. — Lower part of the Vaca Muerta Formation. Bed 3 of the Cerro Lotena section, in association with *P. zitteli* and *G. steueri*.

Age. — Lowermost Middle Tithonian. *P. zitteli* Zone.

Family OPPELIIDAE BONARELLI, 1884

Subfamily TARAMELIGERATINAE SPATH, 1928

Genus PARASTREBLITES DONZE & ENAY, 1961

Type species. — *Oppelia tenuilobata* (OPPEL) var. *circumnodosa* FONTANNES, 1879, p. 23, pl. 3, fig. 6.

Parastreblites comahuensis n. sp.

Pl. 1, Figs. 6a—c; Text-Figs. 2e and 6

? 1926 *Oppelia* (*Neochetoceras*) *Waageni* ZITTEL — KRANTZ, p. 434.

? 1931 *Oppelia* (*Neochetoceras*) *waageni* ZITTEL — WEAVER, p. 399.

Holotype. — *Parastreblites comahuensis* H. LEANZA n. sp., figured in Pl. 1, Figs. 6a—c. S.G.N. 7326.

Locus typicus. — Southern slope of Cerro Lotena, province of Neuquén, Argentina.

Stratum typicum. — Lower part of the Vaca Muerta Formation. *P. zitteli* Zone.

Derivatio nominis. — From Comahue, an araucan name for the region lying between the Colorado and Limay-Negro Rivers, and occupying the province of Neuquén and part of the provinces of La Pampa and Río Negro.

Diagnosis. — Shell strongly involute, compressed, with whorl section higher than wide. Umbilicus narrow and very deep. Venter rather acute but rounded. Ornamentation characterized by fine striae which describe a falcoidal trajectory over the flanks. Suture line with L lobe narrow and much deeper than the E lobe, and 3 accessory lobes (U_2 , U_3 and $U_4 = S$).

Material. — One specimen. S.G.N. 7326: phragmocone very well preserved.

Description. — Because only one specimen was found, little can be added to the diagnosis. The most distinctive features are its suture line (text-fig. 6), similar to that of the genus *Parastreblites*, and its very narrow and deep umbilicus, which represents only 11% of the shell diameter. The umbilical slope is vertical. The maximum width is in the upper part of the internal third of the flanks (text-fig. 2e). The periphery is narrowly rounded. The test is smooth except for some weak striae which cross the flanks fal-

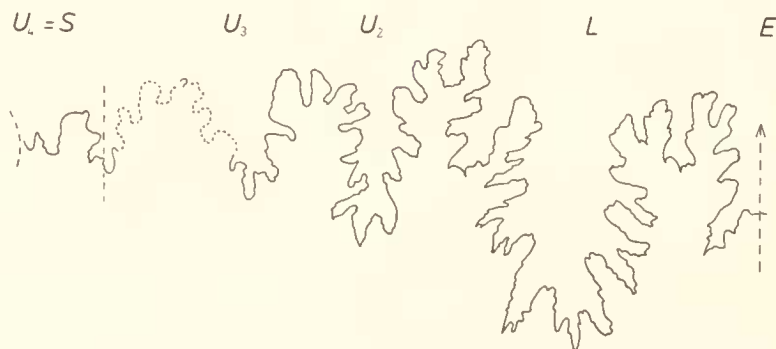


Figure 6: Suture line of *Parastreblites comahuensis* n. sp., S.G.N. 7326/1. $\times 2$.

coidally. The suture line (text-fig. 6) shows an narrow L lobe and 3 accessory lobes (U_2 , U_3 and $U_4 = S$).

M e a s u r e m e n t s. —

Specimen	n°	D	U	U/D	H	W	H/W
S.G.N.	7326	90	10	0.11	53	28	1.89

R e m a r k s. — The specimen resembles "*Oppelia*" *waageni* ZITTEL (1870, pl. 19, fig. 1) in its lack of ornamentation and in its whorl section, which has a rather narrowly rounded venter. In addition the suture line of both displays three accessory elements. However, the specimen from Cerro Lotena clearly differs in having a deeper and narrower umbilicus. The species *waageni* of ZITTEL was included by SPATH (1925, p. 117, footnote) in the genus *Neochetoceras* (type species: *Ammonites steraspis* OPPEL, 1863, p. 251, pl. 69, figs. 1—9). This author implicitly considered *Neochetoceras* to include not only forms with an acute venter, but also those with a rounded venter. Later, DONZE & ENAY (1961, p. 52) transferred "*Oppelia*" *waageni* to *Parastreblites*, originally created by this authors as a subgenus of *Taramelliceras*, considering *Oppelia tenuilobata* (OPPEL) var. *circumnodosa* FONTANNES (1879, p. 23, fig. 6) as type species. DONZE & ENAY stated that its suture line was intermediary between *Taramelliceras* (type species: *Ammonites trachynotus* OPPEL, 1863, pl. 56, fig. 4) and *Metahaploceras* SPATH, 1925 (type species: *Ammonites lingulatus nudus* QUENSTEDT, 1887, p. 852, pl. 92, fig. 55) (cf. HOLDER, 1955, p. 59).

Specifically, the specimen closely resembles *P. waageni* (ZITTEL), and, to a lesser extent, *P. similis* (SPATH, 1925, p. 116, pl. 15, figs. 4a, b). However, the specimen clearly differs in its deeper and narrower umbilicus and in its almost smooth test. *P. holderi* DONZE & ENAY (1961, p. 55, pl. 4, fig. 1, text-fig. 8) also differs by having a somewhat more sculpturated test with falcoidal ribbing. For these reasons, the specimen is proposed as the type of a new species named *P. comahuensis* n. sp., its essential features being a shell shape and suture line similar to those of *Parastreblites*, and a smooth test with deep and narrow umbilicus.

WEAVER (1931, p. 399) as well as KRANTZ (1926, p. 434) have described but not figured some specimens from Cerro Lotena referred to as *Oppelia* (*Neochetoceras*) *waageni*. However, judging by their descriptions, these forms probably belong to *P. comahuensis* n. sp.

O c c u r r e n c e. — Lower part of the Vaca Muerta Formation. Bed 5 of the Cerro Lotena section, in association with *P. zitteli*.

A g e. — Lowermost Middle Tithonian. *P. zitteli* Zone.

Superfamily PERISPHINCTACEAE STEINMANN, 1880

Family PERISPHINCTIDAE STEINMANN, 1890

Subfamily VIRGATOSPHINCTINAE SPATH, 1925

Genus PSEUDINVOLUTICERAS SPATH, 1925

T y p e s p e c i e s. — *Pseudinvoluticeras somalicum* SPATH, 1925, p. 141, pl. 15, figs. 7a—c, text-fig. 10.

The genus *Pseudinvoluticeras* is characterized by an involute shell, vertical umbilical slope and groups of fine ribs which commence in periumbilical swellings which with the age show a tendency to become smooth and distant. The following originally described or subsequently transferred species are known: *P. somalicum* SPATH (1925, p. 141, pl. 15, figs. 7a—c, text-fig. 10), *P. douvillei* SPATH, 1925 (= *Simbirskites barbotanus* DOUVILLÉ non LAHUSEN, 1910, p. 17, pl. 3, figs. 4a, b), *P. mozambicum* COLLIGNON (1960, pl. 159, fig. 631) and *P. cf. P. mozambicum* COLLIGNON (VERMA & WESTERMANN, 1973, p. 182, pl. 29, fig. 1).

The species found in Cerro Lotena, named *P. windhausenii* (WEAVER) n. comb., can now be added to this list.

"*P. decipiens*" SPATH (1925, p. 134; 1950, p. 115), originally based on *Simbirskites payeri* DOUVILLÉ non TOULA (1910, p. 18, pl. 3, figs. 3a, b), is considered for reasons given below as synonymous with *P. douvillei* SPATH. In the same species is also included "*Virgatosphinctes lotenoensis*" WEAVER (1931, p. 423, pl. 48, figs. 322, 323) and "*Virgatosphinctes erinoides*" INDANS non BURCKHARDT (1954, p. 109, pl. 15, fig. 1).

Pseudinvoluticeras douvillei SPATH, 1925
Pl. 3, Figs. 3a—b, 5a—b; Pl. 4, Figs. 2a—b,
Text-Figs. 7a and 8.

- 1910 *Simbirskites barbotanus* DOUVILLÉ (non LAHUSEN), p. 17, pl. 3, fig. 4a-b.
Simbirskites payeri DOUVILLÉ (non TOULA), p. 18, pl. 3, figs. 3a-b.
- 1925 *Pseudinvoluticeras douvillei* SPATH, p. 134 (sp. nov.) (= *S. barbotanus* DOUV. non LAHUSEN).
Pseudinvoluticeras decipiens SPATH, p. 134, (sp. nov.) (= *S. payeri* DOUV. non TOULA).
- 1931 *Virgatosphinctes lotenoensis* WEAVER, p. 423, pl. 48, figs. 322, 323.
- 1954 *Virgatosphinctes erinoides* INDANS (non BURCKHARDT), p. 109, pl. 15, fig. 1.

M a t e r i a l. — 14 specimens in general well preserved. S.G.N. 8904/1—3: three well preserved phragmocones without body chamber. S.G.N. 8885/1: fragment of body chamber. S.G.N. 8894/1: phragmocone not well preserved, without body chamber. S.G.N. 8903/1—3: three small phragmocones, well preserved. S.G.N. 8912/3: small phragmocone fragment. S.G.N. 8899/1—4: four phragmocones, poorly

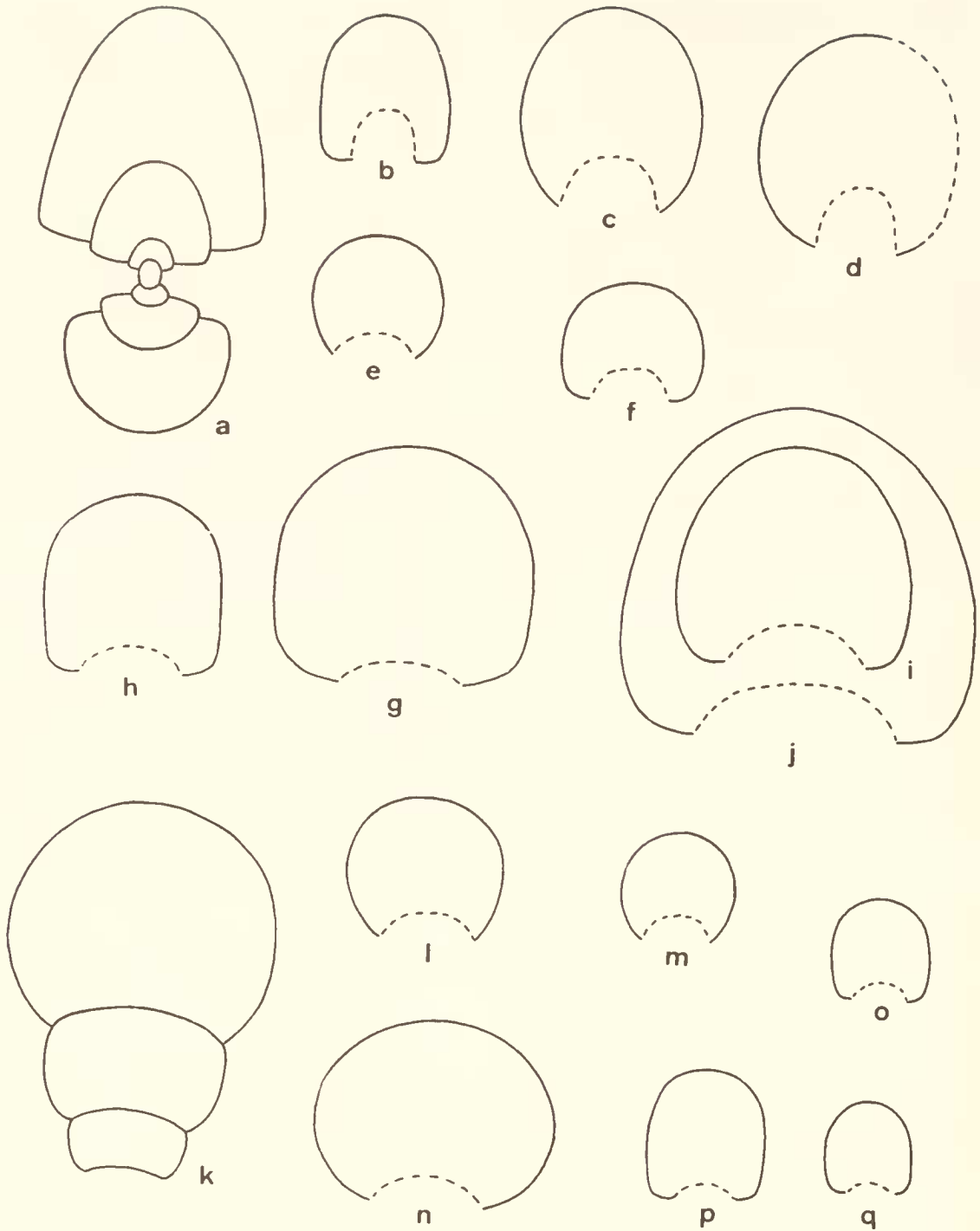


Figure 7: Whorl sections of Virgatospinctinae. a: *Pseudoinvoluticeras douvillei*, S.G.N. 8904/1; b: *P. windhauseni*, S.G.N. 8900/2; c: *Virgatospinctes mexicanus*, S.G.N. 8883; d: *V. andersenii*, S.G.N. 8894/2; e: *V. denseplicatus rotundus*, G.P.I.T. 1545/2; f: *Pseudoinvoluticeras* (?) *wilfridi*, S.G.N. 8898/1; g: *V. evolutus* n. sp., S.G.N. 8901/1 (Holotype); h: *Choicensisphinctes choicensis sutilis* n. ssp., S.G.N. 8902/1 (Holotype); i: *Ch. choicensis*, S.G.N. 8905/3; j: *Ch. erinoides*, S.G.N. 8885/2; k: *Pachysphinctes americanensis* n. sp., S.G.N. 8952/1 (Holotype); l: *Subdichotomoceras araucanense* n. sp., S.G.N. 8935/1 (Holotype); m: *S. windhauseni*, S.G.N. 8940/2; n: *Aulacosphinctoides* aff. *A. hundesianus*, S.G.N. 8934/1; o: *Parapallasiceras* sp. indet., S.G.N. 8942/2; p: *P.* aff. *pseudocolubrinoides*, S.G.N. 8947/1; q: *P.* aff. *recticosta*, S.G.N. 8942/5. Natural size.

preserved. S.G.N. 8884/3: phragmocone fragment, poorly preserved.

Description. — Medium size shell, inflated and involute, with a whorl overlap ranging from 28% to 30% with regard to the diameter of the shell. The whorls are regularly higher than wide, with a H/W ratio ranging from 1.06 to 1.10. The whorl section is subtrapezoidal, but with rounded periphery (text-fig. 7a). The maximum width is at the umbilical border. The umbilicus is narrow and very deep, and the umbilical slope, of diagnostic value, is high and almost vertical. The flanks and the umbilical slope form a rect angle with rounded border, and they are slightly convex, converging to a gently rounded periphery.

The internal whorls are somewhat depressed, and therefore wider than high. Ornamentation is characterized by fine, mostly biplicate ribs and to a lesser proportion virgate ribs. Projected constrictions are also present.

In the last whorl, particularly in the body chamber, the ornamentation changes its aspect due to the formation of periumbilical swellings. In the last whorl there is an average of 30 periumbilical primary ribs, from which originate bundles containing 3 to 4 fine ribs, the more anteriorly-situated being more prorsiradiate, with the posteriorly-situated somewhat rursiradiate. Between these bundles are intercalated secondary ribs which reach the middle of the flank; the shape of these ribs is similar to that of the primary ribs. Both types of ribs cross the venter without interruption. The ribbing in the last part of the body chamber becomes gradually smooth, until only the umbilical swellings remain. In the last whorl there is a total of about 110 primary and secondary ribs.

The suture line (text-fig. 8) is very elaborate; the L lobe is slightly deeper than the E lobe. The E/L saddle is higher and wider than the E/U saddle, and both are asymmetrically divided by two accessory lobes. There are also three elaborate U lobes (U_2 , U_3 and U_4).



Figure 8: Suture line of *Pseudinvoluticeras douvillei* SPATH, S.G.N. 8904/2. $\times 3$.

Measurements. — (better-preserved specimens only)

Specimen	n°	D	U	U/D	H	W	H/W
S.G.N. 8903/2		42	12	0.28	22	20	1.10
S.G.N. 8903/3		49	15	0.30	24	21	1.10
" <i>S. barbatus</i> " Douv.	89	25	0.28	—	—	—	—
" <i>S. payeri</i> " Douv.	84	25	0.29	—	—	—	—
S.G.N. 8904/1		83	24	0.28	37	34	1.08
S.G.N. 8904/2		68	21	0.30	32	30	1.06
S.G.N. 8904/3		67	20	0.29	30	28	1.07
S.G.N. 8905/1		94	29	0.30	38	36	1.05
S.G.N. 8894/1		72	21	0.29	31	29	1.06
S.G.N. 8885/1		97	28	0.28	45	42	1.07
S.G.N. 8903/1		58	17	0.29	24	22	1.09

Remarks. — The material described here can be included in the genus *Pseudinvoluticeras* SPATH, 1925 (type species: *P. somalicum* SPATH, 1925, pl. 15, figs. 7a—c, text-fig. 10), but differs from the genotype in being slightly less involute and also less densely ribbed. On the other hand, it strongly resembles *P. douvillei* SPATH, 1925 (= *Simbirskites barbotanus*

DOUVILLÉ *non* LAHUSEN, 1910, p. 17, pl. 3, figs. 4a, b) in all at its morphologic characteristics.

"*P. decipiens*" SPATH (1925, p. 134), based on "*Simbirskites payeri*" DOUVILLÉ *non* TOULA (1910, p. 18, pl. 3, figs. 3a, b) is apparently conspecific with the species *douvillei* of SPATH. In the original description of "*S. payeri*", DOUVILLÉ (1910, p. 18) stated that "La forme générale, le profil de la coquille, la dimension de l'ombilic, les dimensions et disposition des côtes ombilicales et externes chez l'adulte son tout à fait comparables aux éléments correspondants de l'espèce que nous venons de rapporter à *S. barbotanus*". The essential difference which influenced DOUVILLÉ to separate this "species" appears to be "... la ornamentation très caractéristique de la partie jeune" (op. cit., p. 18). As can be seen in the specimens figured by DOUVILLÉ, the only ones he had available for study, the internal whorls are impossible to compare, because in the specimen of pl. 3, fig. 4a they are entirely covered. Furthermore, "*S. payeri*" has the test preserved only in the first fourth of the last whorl, while "*S. barbotanus*" has it entirely preserved. This would explain the very slight differences in the ornamentation of both specimens. The different U/D ratios (0.28 for "*S. barbotanus*" and 0.29 for "*S. payeri*") fall within the range of variation of the species described here. It is for these reasons that these two "species" are considered here to be conspecific.

As mentioned above, SPATH (1925, p. 134 and 142) considered "*S. barbotanus*" DOUVILLÉ (*non* LAHUSEN) as the type species of *P. douvillei*, and "*S. payeri*" DOUVILLÉ (*non* TOULA) as the type species of *P. decipiens*. On the basis of the analysis made above, and retaining the name of *P. douvillei* because it is better known and has priority in the paper by SPATH (op. cit., p. 134), it is clear that "*S. payeri*" falls into the synonymic list of *P. douvillei*.

Another specimen that can also be included in *P. douvillei*, as already suggested by SPATH (1950, p. 115), is "*Virgatospinctes lotenoensis*" WEAVER (1931, p. 423, pl. 48, figs. 322, 323), found by WEAVER 6.5 km to the west of Cerro Lotena.

"*Virgatospinctes erinoides*" INDANS *non* BURCKHARDT (1954, p. 109, pl. 15, fig. 1), from Portezuelo del Burro, Mendoza, Argentina, can also be included in *P. douvillei* SPATH. INDANS herself noted the strong analogy between this form and "*S. payeri*" DOUVILLÉ and, in fact, it resembles much more *P. douvillei* than the true "*Perisphinctes*" *erinoides* of BURCKHARDT (1903, p. 51, pl. 8, fig. 1), a form much more evolute that is included in this study in the new genus *Choicensisphinctes*.

P. mozambicum COLLIGNON (1960, pl. 159, fig. 631) differs from *P. douvillei* in being more involute and in having weaker periumbilical swellings. Finally,

P. windhauseni (WEAVER) has a more compressed shell and is much more densely ribbed.

O c c u r r e n c e. — Lower part of the Vaca Muerta Formation. Bed 2 of the Cerro Lotena section. Virgatospinctinae Beds. Occurs in association with *Virgatospinctes andesensis*, *V. mexicanus*, *V. burckhardti*, *V. evolutus* n. sp., *V. denseplicatus rotundus*, *P. windhauseni*, *P. (?) wilfridi*, *Choicensisphinctes choicensis*, *Ch. choicensis sutilis* and *Ch. erinoides*.

A g e. — Uppermost Lower Tithonian. *V. mendozanus* Zone.

Pseudinvoluticeras windhauseni (WEAVER, 1931)
n. comb.

Pl. 3, Fig. 2, 4a—b; Text-Fig. 7b.

1931 *Virgatospinctes windhauseni* WEAVER, p. 425, pl. 48, figs. 324, 325.

M a t e r i a l. — 15 specimens, mostly fragments, not very well preserved. S.G.N. 8900/1—10: phragmocone fragments, poorly preserved. S.G.N. 8912/1—2: two phragmocone fragments. S.G.N. 8884/2: phragmocone fragment. S.G.N. 8893/1—2: incomplete phragmocone, badly preserved.

D e s c r i p t i o n. — Shell of medium size, slightly inflated and involute. The diameter of umbilicus ranges from 23% to 26% of the whorl overlap. The umbilicus is narrow and deep, and the umbilical wall almost vertical; the flanks and the umbilical wall form a rect angle with rounded border. The whorl section is elliptical, with somewhat convex flanks converging rapidly to a widely convex periphery (cf. text-fig. 7b). The maximum width is at the umbilical border. In the internal whorl the ornamentation is characterized by very fine, regularly spaced ribs, which begin in the umbilical wall, crossing it in a somewhat rursiradiate direction. At the umbilical border, they gradually turn towards the aperture; on the flanks they clearly project and cross the venter without interruption. Near the base of the middle third of the flank, the ribs begin to bi- or triplicate, but maintain the same prominence.

In the last part of the body chamber there is a tendency towards formation of periumbilical swellings, and also a gradual decrease in the prominence of the ribbing, leading to the formation of smoother surfaces.

Because of the fragmentary preservation of the material, the number of ribs could not be established exactly; it is estimated as consisting of 50 primaries and 130 secondaries. The poor preservation also precluded determination of the suture line.

Measurements. — (better preserved specimens only)

Specimen	n°	D	U	U/D	H	W	H/W
"V." <i>windhauseni</i>							
WEAV., spec. n° 1	85	20	0.23	19	18.5	1.02	
S.G.N. 8900/2	49	11	0.22	22	20	1.10	
S.G.N. 8900/3	50	12	0.24	22	20	1.10	
S.G.N. 8900/4	57	14	0.24	25	19	1.31	
S.G.N. 8900/5	51	12	0.23	22	20	1.10	
S.G.N. 8900/6	30	7	0.23	13	13	1.00	

Remarks. — The coiling of the shell, narrow and deep umbilicus, almost vertical umbilical slope, and ribbing with a tendency to form periumbilical swellings and smooth surfaces in the body chamber, together suggest that the material can be included in the genus *Pseudinvoluticeras*.

Specifically, it shows very close correspondence to "*Virgatosphinctes*" *windhauseni* WEAVER (1931, p. 425, pl. 48, figs. 324, 325), which was also found by WEAVER in the Cerro Lotena area. Therefore, the name *P. windhauseni* (WEAVER) n. comb. is proposed.

None of the species of *Pseudinvoluticeras* known to date shows such fine and dense ribbing as the described material. This characteristic is therefore considered to be of diagnostic value.

"*Virgatosphinctes*" (*Lithacoceras*) *tenuilineatus* INDANS (1954, p. 103, pl. 13, figs. 1, 2), contrary to the view of DONZE & ENAY (1961, p. 70), falls more properly in *Pseudinvoluticeras* than in *Lithacoceras*, and appears to be closely related to *P. windhauseni*.

Occurrence. — Lower part of the Vaca Muerta Formation. Bed 2 of the Cerro Lotena section (*Virgatosphinctinae* Beds), in association with *Virgatosphinctes andesensis*, *V. mexicanus*, *V. burckhardti*, *V. evolutus*, *V. denseplicatus rotundus*, *Pseudinvoluticeras douvillei*, *P. (?) wilfridi*, *Choicensisphinctes choicensis*, *Ch. choicensis sutilis* and *Ch. erinoides*.

Age. — Uppermost Lower Tithonian. *V. mendozanus* Zone.

Pseudinvoluticeras (?) wilfridi (DOUVILLÉ, 1910)

Pl. 5, Figs. 3a—b; Text-Fig. 7f.

1910 *Holcodiscus wilfridi* DOUVILLÉ, p. 12, pl. 2, fig. 6.

1954 *Virgatosphinctes wilfridi* (DOUVILLÉ) — INDANS, p. 107, pl. 13, fig. 3.

Material. — One specimen. S.G.N. 8898/1: phragmocone well preserved, but internal whorls not very apparent.

Description. — The shell is discoidal, small and relatively involute. The umbilicus is narrow and deep. The U/D ratio = 0.31. The whorls are somewhat inflated and wider than high. The umbilical wall is strongly inclined, almost vertical. The umbilical wall and the flanks form a rectangle with rounded edge. The flanks are subplanate and rapidly

converge to a widely-rounded periphery. The ornamentation is characterized by fine and dense ribbing. The ribs commence in the umbilical slope, where they are somewhat rursiradate. At the umbilical border they bend forward, describing a sigmoidal trajectory over the flanks. The ribbing is characterized by dichotomic or virgatotomic branching at different heights on the flanks. The branched ribs maintain the same prominence as the primaries, and cross the venter without interruption. In the last volution there are three rather unclear constrictions, anteriorly bordered by a simple rib and posteriorly by virgate bundles. The suture line could not be detected.

Measurements. —

Specimen	n°	D	U	U/D	H	W	H/W
S.G.N. 8898/1	45	14	0.31	17	21	0.80	

Remarks. — The specimen, which consists of the internal whorls of the phragmocone, is surprisingly similar to that figured as "*Holcodiscus*" *wilfridi* by DOUVILLÉ (1910, p. 12, pl. 2, fig. 6). This species, coincidentally, is also based on an incomplete phragmocone which only shows the internal whorls. The specimen figured by INDANS (1954, p. 107, pl. 13, fig. 3) is also very similar. A problem arises as to where this species should be generically placed, because its attribution to the genus *Virgatosphinctes* UHLIG, as made by INDANS (1954) — perhaps influenced by the words of UHLIG (1911a, p. 542) — does not appear to be acceptable. Although this species resembles *Virgatosphinctes* of the *denseplicatus* group, the similarity is only superficial because its whorl section is somewhat more inflated, the umbilical slope is almost vertical and the shell is more involute, all features which are absent in *Virgatosphinctes*. The enigmatic species *wilfridi* of DOUVILLÉ could also be included either in the genus *Aulacosphinctoides* or *Pseudinvoluticeras*. UHLIG himself, in discussing the inclusion of DOUVILLÉ's species in his genus *Virgatosphinctes*, stated with regard to "*V.*" *wilfridi* that "Vielleicht bildet diese Art das Jugendstadium des *Simbirskites payeri* R. DOUV." UHLIG, 1911a, p. 542). As mentioned above, "*S. payeri*" is actually included in *Pseudinvoluticeras*.

In view of the lack of material, the specimen described here is provisionally attributed to the genus *Pseudinvoluticeras* with interrogant, though bearing in mind the problem outlined above.

Perisphinctes (Aulacosphinctes) wilfridi BURCKHARDT non DOUVILLÉ (1921, p. 51, pl. 17, figs. 1—3) has no relation to the form described here and is probably an *Aulacosphinctoides* (cf. SPATH, 1927—33, p. 533).

Occurrence. — Lower part of the Vaca Muerta Formation. Bed 2 of the Cerro Lotena sec-

tion (*Virgatosphinctinae* Beds), in association with *V. andesensis*, *V. mexicanus*, *V. burckhardti*, *V. evolutus*, *V. denseplicatus rotundus*, *P. douvillei*, *P. windhausenii*, *Ch. choicensis*, *Ch. choicensis sutilis* and *Ch. erinoides*.

A g e. — Uppermost Lower Tithonian. *V. men-do-zanus* Zone.

Genus VIRGATOSPINCTES UHLIG, 1910

Type species. — *Perisphinctes (Virgatosphinctes) broilii* UHLIG, 1910, p. 336, pl. 91, figs. 1a—d. SDR. DOUVILLÉ, 1910a, p. 737.

The controversial and variable genus *Virgatosphinctes*, which was originally described by UHLIG (1910) from the Spiti Shales of India, has been the subject of much discussion, and, until recently, its presence in the Andean domain has not been fully accepted (cf. R. ENAY, 1972, p. 374).

Before beginning any analysis of the problem, it is worthwhile to recall the words of UHLIG himself in the introduction of his subgenus *Virgatosphinctes*, stating that "... In no other group is the variability so great as in the present one; every character undergoes an almost incredible degree of fluctuation. Hardly a single specimen resembles another one in every detail..." (UHLIG, 1910, p. 308). Although *Virgatosphinctes* was immediately typified by R. DOUVILLÉ (1910a, p. 737), who designated *V. broilii* UHLIG as the type species, the words of UHLIG did not lose their import to those dealing with this polyfacetic genus, and were reiterated by SPATH (1927—33, p. 532 and followings) in his description of the Jurassic cephalopod fauna of Cutch.

It should be noted that UHLIG himself (1910, p. 312, 1911a, 1911b) had suggested that many of the forms previously figured as *Virgatites* by BURCKHARDT (1903) could be included in the genus *Virgatosphinctes*, though this point of view was strongly rejected by BURCKHARDT (1911a, 1911b, 1930).

Although the Andean *Virgatosphinctes* appears to be a group with variable characteristics (cf. STEIGER, 1914, p. 497 and following), most specimens clearly display the diagnostic features of this genus. In any case, it is not reasonable to refute the presence of *Virgatosphinctes* in the Andean Tithonian if such Himalayan forms as *Aulacosphinctoides*, *Torquatisphinctes*, *Aulacosphinctes*, *Himalayites* and *Subdichotomoceras* are accepted without reservation. The Cerro Lotena section has yielded several examples of *Virgatosphinctes*, represented by the species *V. andesensis*, *V. mexicanus*, *V. burckhardti*, *V. denseplicatus rotundus* and *V. evolutus* n. sp., which are described below.

It is also worth noting that affinities exist between *Virgatosphinctes* and *Subplanites*. As stated by the

author who defined the latter genus "the resemblances of this group with the true *Virgatosphinctes* is often close" (SPATH, 1925, p. 120). However, when SPATH established the genus *Subplanites* (type species: *Virgatosphinctes reisi* SCHNEID, 1914, p. 163, pl. 6, fig. 2), he did not give an adequate diagnosis and therefore it was the subject of much misinterpretation among later authors. SPATH himself, while describing the Jurassic fauna of Cutch, stated that the forms described under *Subplanites* (v. gr. *S. elegans*, *S. adeloides*, *S. ? flexuosus*) "are more closely allied to *Perisphinctes contiguus* (ZITTEL) UHLIG" (SPATH, 1927—33, p. 468) than to the typical *reisi-schlosseri-subdanubiensis* group of Neuburg, "... but the frequent confusion of *contiguus*-like species of *Subplanites* with the true *Virgatosphinctes* shows that the two genera are closely similar at certain stages".

More recently, HÖLDER (in BERCKHEMER & HÖLDER, 1959, p. 51) placed *Virgatosphinctes reisi* SCHNEID, the type species of *Subplanites*, in the synonymic list of *Perisphinctes (Virgatosphinctes) rupellianus*. The cited examples clearly show that the two genera are closely related.

Although many specimens from Cerro Lotena resemble *Subplanites*, it appears more reasonable to include them in *Virgatosphinctes* on the basis of (1): whorl section, which is subcircular and somewhat depressed in most cases, a feature atypical of *Subplanites*, and (2): suture line, which is relatively simple in contrast to that of *Subplanites*, where the accessory lobe dividing the E/U saddle is strongly oblique and the U lobes are much more elaborate.

For the above reasons, the present author includes some specimens from Cerro Lotena in the genus *Virgatosphinctes*, though bearing in mind its close affinities with the genus *Subplanites*.

Virgatosphinctes mexicanus (BURCKHARDT, 1906)

Pl. 2, Figs. 1a—b; Text-Fig. 7c.

1906 *Virgatites mexicanus* BURCKHARDT, p. 115, pl. 31, figs. 5-9.

1910 *Virgatites mexicanus* BURCKHARDT — DOUVILLÉ, p. 8, pl. 1, figs. 1-2.

1954 *Virgatosphinctes mexicanus* (BURCKHARDT) — INDANS, p. 113, pl. 18, fig. 1.

Material. — One specimen. S.G.N. 8883: phragmocone fragment with remains of body chamber.

Description. — Discoidal shell, rather evolute, with the whorls overlapping the external third of the flanks of the precedents. U/D ratio = 0.44. Whorl section subelliptical, somewhat higher than wide (text-fig. 7c). Umbilical slope inclined, umbilical border rounded, with slightly convex flanks converging to a rounded periphery. The umbilicus is wide and relatively deep. Ribbing on the internal whorls, with probable bifurcation at the external third of the

flank. In the last whorl the ribbing becomes virgatous. The virgate ribs commence at different heights on a projected primary rib; a further division occurs at a level somewhat higher on the flanks. Constrictions are also present, and are prorsiradiate, and anteriorly-bordered by a stronger rib. The suture line could not be observed.

Measurements. —

Specimen	n°	D	U	U/D	H	W	H/W
S.G.N.	8883	95	42	0.44	31	28	1.10

Remarks. — All of the described morphological characteristics agree with those of the genus *Virgatospinctes* UHLIG (1910). Specifically the specimen strongly resembles *Virgatospinctes mexicanus* (BURCKHARDT, 1906, p. 115, pl. 31, figs. 5—9).

The specimens figured by DOUVILLÉ (1910, p. 8, pl. 1, figs. 1, 2) and INDANS (1954, p. 113, pl. 18, fig. 1) from the provinces of Neuquén and Mendoza, respectively, belong without doubt to BURCKHARDT's species, though the specimens from Neuquén are somewhat more densely ribbed in the internal whorls.

Occurrence. — Lower part of the Vaca Muerta Formation. Bed 2 of the Cerro Lotena section (*Virgatospinctinae* Beds), in association with *V. andesensis*, *V. burckhardti*, *V. evolutus*, *V. denseplicatus rotundus*, *P. douvillei*, *P. windhauseni*, *P. (?) wilfridi*, *Ch. choicensis*, *Ch. choicensis subtilis* and *Ch. erinoides*.

Age. — Uppermost Lower Tithonian. *V. mendozanus* Zone.

Virgatospinctes andesensis (DOUVILLÉ, 1910)

Pl. 2, Figs. 5a—b; Text-Figs. 7d and 9.

- 1910 *Virgatites andesensis* DOUVILLÉ, p. 17, pl. 1, figs. 3a-b, 4a-f.
 1931 *Virgatospinctes andesensis* (DOUVILLÉ) — WEAVER, p. 422, pl. 47, figs. 313, 314; pl. 48, figs. 318—321.
 1954 *Virgatospinctes andesensis* (DOUVILLÉ) — INDANS, p. 111, pl. 13, fig. 9; pl. 16, figs. 1—5.
 1958 *Virgatospinctes andesensis* (DOUVILLÉ) — CORVALÁN, p. 43, pl. 8, figs. 18a, b.

Material. — One specimen. S.G.N. 8894/2: phragmocone well preserved, with two thirds of the last whorl belonging to the body chamber. One side somewhat deteriorated and crushed.

Description. — Discoidal shell, evolute. U/D ratio = 0.41. Whorl section suboval, somewhat higher than wide (text-fig. 7d). Umbilical slope strongly inclined, umbilical border rounded with slightly convex flanks converging to a rounded periphery. The body chamber occupies two thirds of the last whorl. The ornamentation is well defined, and composed of prominent primary ribs that commence near the base of the umbilical slope, where they are somewhat rursiradiate. At the umbilical border they become narrow and more prominent, crossing the internal part of the flank prorsiradiately and the external part radially. The ribs display a slight inflection in the middle part of the flank. There is also a virgatotic branching of the ribs at different heights on the flanks. A given rib can be divided into two in the lower part of the flank. A further division occurs at a level somewhat higher on the flanks, as was described by UHLIG (1910, p. 306) in his diagnosis of *Virgatospinctes*. This type of division becomes more evident towards the aperture of the shell, particularly at the body chamber. In the phragmocone, it is more common to find bi- or trifurcate ribs. The virgate ribs situated anteriorly project strongly, while the posterior ones are radial or somewhat rursiradiate. There are also intercalatory ribs which disappear on the internal third of the flank. The virgate and intercalatory ribs cross the venter without interruption. In the last whorl there are 42 primary ribs and 107 secondary ribs on the periphery. In the body chamber a nitid constriction is present which is first projected and then radial, and which is anteriorly bordered by a fine, prominent rib.

The suture line (text-fig. 9) has E and L lobes of the same depth, the E/L saddle is wider than the E/U saddle and there are two somewhat oblique U lobes of decreasing depth.

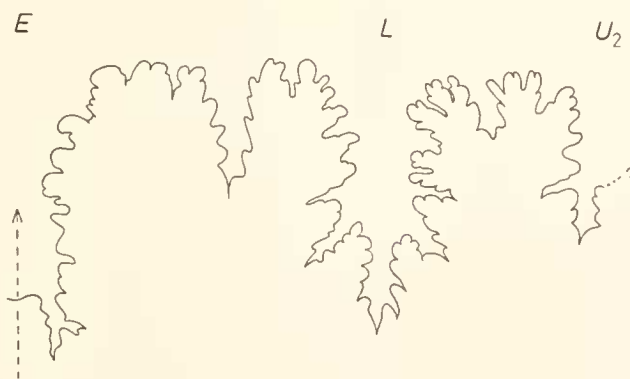


Figure 9: Suture line of *Virgatospinctes andesensis* (DOUV.), S.G.N. 8894/2. $\times 3$.

Measurements. —

Specimen	n°	D	U	U/D	H	W	H/W
S.G.N.	8894/2	96	40	0.41	33	31	1.06

Remarks. — On the basis of the diagnosis of *Virgatospinctes* (cf. DOUVILLÉ, 1910a, p. 737; ARKELL *et al.*, 1957, p. L 330), the specimen can be assumed to belong to this genus. The whorl section, rate of whorl overlap, umbilical slope, and the ribbing characterized in the internal whorls by bi- or tricotomic branching and in the external ones by virgatotomic branching as described by UHLIG, indicate that the specimen can unquestionably be included in the genus *Virgatospinctes*.

Specifically, it closely resembles *V. andesensis* (DOUVILLÉ, 1910, p. 17, pl. 1, figs. 3a—b; 4a—f), but it resembles even more the specimens attributed to the same species by WEAVER (1931) and INDANS (1954), in whose respective illustrations a rather notable variability in the ornamentation can be observed. In the described specimen, as well as in those figured by the above authors, the umbilicus is somewhat narrower than that of the larger specimen of DOUVILLÉ (1910, pl. 1, fig. 3a), though this difference may be only an apparent one because the umbilical border of the DOUVILLÉ species is partially covered by matrix which prevents observation of the line of coiling. The specimen of this study is almost identical to that figured by WEAVER (1931, pl. 47, figs. 313 and 314), which also comes from Cerro Lotena.

"*Virgatospinctes*" *sanchezi* VERMA & WESTERMANN (1973, p. 185, pl. 32, pl. 33, pl. 34, fig. 2, text-fig. 15) from the Tithonian of Sierra Catorce, Mexico, has an inverted ontogeny with regard to *Virgatospinctes*, showing transposed stages of ornamentation, that is, virgate ribs occur in the young stage while simple and bipartite ribs are present in the adult stage.

Occurrence. — Lower part of the Vaca Muerta Formation. Bed 2 of the Cerro Lotena section (*Virgatospinctinae* Beds), in association with *V. mexicanus*, *V. burckhardti*, *V. evolutus*, *V. denseplicatus rotundus*, *P. douvillei*, *P. windhauseni*, *P. (?) wilfridi*, *Ch. choicensis*, *Ch. choicensis utilis* and *Ch. erinoides*.

Age. — Uppermost Lower Tithonian. *V. mendozanus* Zone.

Virgatospinctes burckhardti (DOUVILLÉ 1910)

Pl. 5, Figs. 2a—b.

1903 *Virgatites* aff. *Quenstedti* BURCKHARDT (*non* ROUILL), p. 42, pl. 6, figs. 104.

1910 *Virgatites Burckhardti* DOUVILLÉ, p. 10 (sp. nov.).

1910 *non Perisphinctes (Virgatospinctes) Burckhardti* UHLIG, p. 332, pl. 62, figs. 3a-c.

1954 *Virgatospinctes (Lithacoceras ?) burckhardti* (DOUVILLÉ) — INDANS, p. 103, pl. 13, figs. 4—5.

Material. — One specimen. S.G.N. 8896/1: well-preserved incomplete phragmocone, with remains of body chamber.

Description. — Medium size shell, moderately evolute. U/D ratio = 0.35. Whorl section depressed, with the maximum width at the umbilical border. Umbilical slope strongly inclined, umbilical border rounded and flanks slightly convex, converging to a widely rounded periphery. The ornamentation is fine, densely ribbed and typically virgate. The primary ribs commence at the umbilical seam, and cross the umbilical slope rursiradiately. At the umbilical border they become stronger, and on the flanks they are prorsiradiate. In the internal third of the flank, the ribs shows virgatotomic branching, resulting in new divisions in the upper third of the flanks. In the last half of the last whorl there are 21 primary ribs at the umbilical border and 72 secondaries on the periphery. All the ribs cross the venter without interruption. Constrictions are usually present, following the direction of the ribbing. They are generally anteriorly bordered by a single rib. The suture line could not be observed.

Measurements. —

Specimen	n°	D	U	U/D	H	W	H/W
S.G.N.	8896/1	57	20	0.35	21	25	0.84

Remarks. — The specimen coincides in its morphological characteristics with the genus *Virgatospinctes* UHLIG. Specifically, it shows close affinities with *V. burckhardti* (DOUVILLÉ, 1910, p. 10), which is based on "*Virgatites* aff. *quenstedti*" BURCKHARDT *non* ROUILL (1903, p. 42, pl. 6, figs. 1—4). The specimen figured by INDANS as *Virgatospinctes (Lithacoceras ?) burckhardti* (see synonymic list) also coincides with the described specimen.

V. densistriatus (STEUER, 1897, p. 62, pl. 15, figs. 8 to 10) differs in its less evolute shell and more distant primaries. Also *V. denseplicatus* (WAAGEN, 1875, p. 201, pl. 45, figs. 3a—b; pl. 55, figs. 1a—b) is also a closely similar form, but differs in its larger evolution and denser, less prominent ribbing. *V. haughtoni* SPATH (1927—33, p. 534, pl. 77, fig. 6) from Madagascar and "*Perisphinctes*" *aguilari* BURCKHARDT (1906, p. 110, pl. 27, figs. 6—9) from Mexico are also close species, but they differ from *V. burckhardti* in its less vigorous primaries, which are more distant and less projected.

It is worth noting that "*Perisphinctes*" (*Virgatospinctes*) *burckhardti* UHLIG (1910, p. 332, pl. 62, figs. 3a-c) is a species which is more closely allied to *Subplanites*, and does not belong to the DOUVILLÉ species described here.

Occurrence. — Lower part of the Vaca Muerta Formation. Bed 2 of the Cerro Lotena section

(Virgatosphinctinae Beds), in association with *V. mexicanus*, *V. andesensis*, *V. evolutus*, *V. denseplicatus rotundus*, *P. douvillei*, *P. windhauseni*, *P. (?) wilfridi*, *Ch. choicensis*, *Ch. choicensis sutilis* and *Ch. erinoides*.

Age. — Uppermost Lower Tithonian. *V. mendozanus* Zone.

Virgatosphinctes denseplicatus rotundus SPATH, 1931
Pl. 2, Figs. 2 and 3; Text-Fig. 7e.

1931 *Virgatosphinctes denseplicatus* (WAAGEN) var. *rotunda* SPATH — in SPATH, 1927-33, p. 532, pl. 96, figs. 3a-b; pl. 102, fig. 4.

1954 *Virgatosphinctes* cf. *denseplicatus* (WAAGEN) var. *rotunda* SPATH — INDANS, p. 106, pl. 21, fig. 1.

Material. — Two specimens. S.G.N. 8905/1: well preserved phragmocone, with the last part of the last whorl somewhat crushed. G.P.I.T. 1545/2: very well preserved phragmocone.

Description. — The shell is discoidal and rather small. Umbilicus relatively narrow but not deep. U/D ratio = 0.35 to 0.39. Umbilical slope strongly inclined, umbilical border rounded, and flanks gently convex, gradually converging to a rounded periphery. Whorl section subelliptical and somewhat wider than high (text-fig. 7e). Ornamentation dense and formed of fine ribs that commence in the middle of the umbilical slope; in the flank they are somewhat prorsiradial and they cross the periphery without interruption. Virgatotomic and dicotomic branching of the ribs occurs in the last whorl. Constrictions are also present, and are anteriorly bordered by a rib of similar prominence to the others. The suture line could not be observed.

Measurements. —

Specimen	n°	D	U	U/D	H	W	H/W
S.G.N.	8905/1	57	20	0.35	24	?	—
G.P.I.T.	1545/2	46	18	0.39	19	21	0.90

Remarks. — In shape the described specimen closely resembles *V. denseplicatus* (WAAGEN, 1875, p. 201, pl. 46, figs. 3a, b; pl. 55, figs. 1a, b), and corresponds exactly to the variety *rotundus* of SPATH (1931, p. 532, pl. 96, figs. 3a, b; pl. 102, fig. 4). SPATH stated that "It is possible that this variety also includes the immature form figured in Pl. 102, fig. 4, although its umbilicus is somewhat too narrow" (SPATH, 1927 to 33, p. 533). The specimen described in this study appears to be identical to this immature form referred to by SPATH.

V. denseplicatus (WAAGEN) from west Pakistan, figured by FATMI (1972, p. 346, pl. 9, figs. 1a—b), also closely resembles the described material.

V. densistriatus (STEUER, 1897, p. 63, pl. 15, figs. 8 to 10) also resembles this variety, although it was sug-

gested by SPATH (1927—33, p. 534) to be a Pseudovirgatitid.

Occurrence. — Lower part of the Vaca Muerta Formation. Bed 2 of the Cerro Lotena section (Virgatosphinctinae Beds), in association with *V. mexicanus*, *V. andesensis*, *V. burckhardti*, *V. evolutus*, *P. douvillei*, *P. windhauseni*, *P. (?) wilfridi*, *Ch. choicensis*, *Ch. choicensis sutilis* and *Ch. erinoides*.

Age. — Uppermost Lower Tithonian. *V. mendozanus* Zone.

Virgatosphinctes evolutus n. sp.
Pl. 5, Figs. 4a—c; Text-Fig. 7g.

1903 *Perisphinctes* aff. *transitorius* BURCKHARDT (non OPPEL), p. 40, pl. 5, figs. 4-9.

Perisphinctes contiguus BURCKHARDT (non CATULLO), p. 38, pl. 4, figs. 7—10.

1931 *Aulacosphinctes* cf. *A. transitorius* (OPPEL) — WEAVER, p. 415, pl. 45, fig. 306.

Holotype. — *Virgatosphinctes evolutus* H. LEANZA n. sp., figured in Pl. 5, Figs. 4a—c, Text-Fig. 7g of this paper. S.G.N. 8901/1.

Locus typicus. — Southern slope of Cerro Lotena, province of Neuquén, Argentina.

Stratum typicum. — Lower part of the Vaca Muerta Formation. *V. mendozanus* Zone.

Derivatio nominis. — From the evolute character of the shell.

Diagnosis. — Shell strongly evolute, with whorl section subcircular, somewhat depressed. Ornamentation in the internal whorls consists of elevated and narrow biplicate ribs; in the outer whorls these become gradually triplicate and virgatotomic. Constrictions are present. Suture line with trifid L lobe of almost the same depth as the E lobe. The E/L and E/U saddles are not very elaborate and are separated by small lobes into two asymmetrical saddles. There are also two U lobes which are somewhat oblique and not very elaborate.

Material. — One specimen. S.G.N. 8901/1: well preserved phragmocone with body chamber, which occupies almost half of the last volution.

Description. — The shell is discoidal and evolute. U/D ratio = 0.43. The last whorl section is subcircular and somewhat depressed (cf. text-fig. 7g). The periphery is slightly convex, the flanks are very gently convex, the umbilical border is very well rounded, and the umbilical slope is moderately inclined. Almost half of the last whorl belongs to the body chamber. The phragmocone is composed entirely of calcite which has eliminated all traces of the suture line except that limiting with the body chamber,

which is fossilized in limestone. The last volution contains 49 primary ribs which commence at the umbilical slope, where they are rursiradiate. They bend forward on the umbilical border, and are prorsiradiate on the flanks. In the portion of the last whorl corresponding to the phragmocone, almost all the primary ribs are divided in two branches, both of the same prominence. In this portion, two or three intercalatory ribs are also preserved, which extend from the external part of the shell to the middle of the flanks.

There are also two examples of virgatotomic branching which are limited anteriorly by constrictions. In the portion of the whorl belonging to the body chamber, numerous virgate and triplicate examples of ribbing are observed, but only one case of bifurcation is present, located at the beginning of the body chamber. Three nitid constrictions are also present in this portion of the volution; they are limited anteriorly by a single rib and posteriorly by trifurcate or virgate ribs.

The suture line, preserved in a septum linking with the body chamber, shows a trifold L lobe of almost the same depth as the E lobe. The E/L and E/U saddles are not very elaborate and are separated by small lobes into two asymmetrical saddles. There are also two U lobes which are somewhat oblique and not very elaborate.

Measurements. —

Specimen	n°	D	U	U/D	H	W	H/W
S.G.N.	8901/1	106	46	0.43	35	38	0.92

Remarks. — This new species is closely related to *Perisphinctes* aff. *transitorius* BURCKHARDT (non OPPEL) (1903, p. 40, pl. 5, figs. 4—9) and *Perisphinctes contiguus* BURCKHARDT (non CATULLO) (1903, p. 38, p. 4, figs. 7—10), both from Casa Pincheira, southern Mendoza, Argentina. It differs only in its more depressed whorl sections, perhaps because they represent younger ontogenetic stages. Therefore, these two species are included in the synonymic list.

It is possible that "*Aulacosphinctes*" cf. *transitorius* WEAVER (non OPPEL) (1931, p. 415, pl. 45, fig. 306) also belongs to the newly-described species.

"*Perisphinctes* aff. *pseudolictor*" CHOFFAT (BURCKHARDT, 1903, p. 36, pl. 5, figs. 1—6), later renamed by SPATH as *Subplanites malargüensis*, is a form superficially similar to *V. evolutus* n. sp. differing only in its more compressed whorls and its more elaborate suture line.

With regard to the evolute *Virgatosphinctes* described by UHLIG from the Spiti Shales, *V. evolutus* n. sp. strongly resembles *V. haydeni* UHLIG (1910, p. 334, pl. 61, figs. 2a, d). With respect to the species from Madagascar, *V. rouselli* COLLIGNON (1960, pl. 157, fig. 630) it is the closer related species.

Occurrence. — Lower part of the Vaca Muerta Formation. Bed 2 of the Cerro Lotena section (Virgatosphinctinae Beds), in association with *V. andensis*, *V. mexicanus*, *V. burckhardti*, *V. denseplicatus rotundus*, *P. douvillei*, *P. windhausenii*, *P. (?) wilfridi*, *Ch. choicensis*, *Ch. choicensis utilis* and *Ch. erinoides*.

Age. — Uppermost Lower Tithonian. *V. mendozanus* Zone.

Genus CHOICENSISPHINCTES nov.

Type species. — *Perisphinctes choicensis* BURCKHARDT, 1903, p. 50, pl. 6, figs. 10—12; pl. 8, fig. 6.

Diagnosis. — Discoidal, somewhat inflated and rather evolute shell. Whorl section subtrapezoidal, with rounded borders, wider than high. Ornamentation of the internal whorls regularly biplicate. Outer whorls display strong, prominent and projected primary ribs. Periumbilical swellings originate from bundles of 4 to 10 fine equally spaced, somewhat projected secondary ribs which cross the venter without interruption. No virgatotomic branching occurs. Constrictions are present. Suture line has trifold L lobe as deep as E, and E/L saddle wider and higher than E/U saddle. Two U lobes are present which are very simple and not oblique.

Locus typicus. — Area between Cajón del Burro and the Choica-River valley, at the beginning of the Rio Grande river, Mendoza province, Argentina.

Stratum typicum. — Lower part of the Vaca Muerta Formation. *V. mendozanus* Zone.

Derivatio nominis. — After the species of BURCKHARDT, *P. choicensis*, which is itself named after the Choica River, its locus typicus.

Discussion. — *Choicensisphinctes* gen. nov. is here proposed to include those ammonites having an inflated and rather evolute shell of olcostephanid aspect, and ornamentation characterized by bundles of 4 to 10 ribs. These forms constitute an homogeneous stock including the species "*P.*" *choicensis*, "*P.*" *erinoides* and "*P.*" aff. *erinus* of BURCKHARDT (1903). It is worth recalling that UHLIG himself (1911a, p. 542) had already suggested that the cited species of BURCKHARDT could be grouped as a determinate group of ammonites.

With regard to "*P.*" *choicensis*, DOUVILLÉ (1910a, p. 738) stated that it could not be placed in the so-called Andean *Virgatites*, which was later transferred

to *Virgatosphinctes*. Moreover, UHLIG (1910, p. 336) pointed out that BURCKHARDT's species could be differentiated from his genus *Virgatosphinctes* (v. gr. *V. krafti* UHLIG) "by its narrower umbilicus, trapezoid cross section, simpler suture and much more numerous branch ribs".

The species *erinoides* of BURCKHARDT (1903, p. 51, pl. 8, figs. 1—4) was included successively in the genera *Olcostephanus* (BURCKHARDT, 1930, p. 111, 112), *Aulacosphinctes* (WEAVER, 1931, p. 417), *Pararosenia*? (SPATH, 1927—33, p. 469) and *Virgatosphinctes* (INDANS, 1954, p. 109), but none of these generic attributions appears to be plausible. However, as shown below, it can probably be included in *Choicensisphinctes*.

Finally, *P. aff. erinus* (D'ORB.) BURCKHARDT (1903, p. 52, pl. 9, figs. 1—2; pl. 8, fig. 5), which was later renamed by BURCKHARDT himself (1930, p. 110) as *Craspedites limitis*, probably incorrectly, can also be included more properly in *Choicensisphinctes*.

Choicensisphinctes gen. nov. differs from *Virgatosphinctes* UHLIG, 1910 (type species: *V. broilii* UHLIG, SD DOUVILLÉ, 1910a), in addition to the differences already pointed out by UHLIG, in its more inflated shell, its strongly inclined umbilical wall, and the absence of virgatotomic branching.

The genus *Pseudinvoluticeras* SPATH, 1925 (type species: *P. somalicum* SPATH, 1925) in some cases shows a similar ornamentation, but it is always more involute.

Choicensisphinctes therefore represents a transitional form between *Virgatosphinctes* and *Pseudinvoluticeras*: it exhibits the coiling of the former, but an ornamentation more similar to the latter.

Other genera which show close affinities with *Choicensisphinctes* gen. nov. are *Sublithacoceras*, *Phanerostephanus* and *Usseliceras*. *Sublithacoceras* SPATH, 1925 (type species: *Perisphinctes penicillatus* SCHNEID, 1915) is much more compressed and shows a tendency towards smooth surfaces in the body chamber. The suture line is also much more elaborate. *Phanerostephanus* SPATH, 1950 (type species: *P. sub-senex* SPATH, 1950) is more involute and displays periumbilical swellings without ribbing in the last whorls. Finally, *Usseliceras* ZEISS, 1968 (type species: *U. franconicum* ZEISS, 1968), from south Franconia area, is very similar with regard to the ornamentation, but differs in being much more compressed, with whorls higher than wide.

Occurrence. — Very common in the basal beds of the Vaca Muerta Formation within the Neuquén and Mendoza basin. Bed 2 of the Cerro Lotena section (*Virgatosphinctinae* Beds).

Age. — Lower Tithonian. *V. mendozanus* Zone.

Choicensisphinctes choicensis (BURCKHARDT, 1903)
Pl. 2, Figs. 4a—b; Text-Fig. 7i.

- 1903 *Perisphinctes choicensis* BURCKHARDT, p. 50, pl. 6, figs. 10—12; pl. 8, fig. 6.
1931 *Aulacosphinctes* cf. *A. choicensis* (BURCKHARDT) — WEAVER, p. 414.
1954 *Virgatosphinctes* cf. *raja* UHLIG — INDANS, p. 110, pl. 14, fig. 1-3.

Material. — One specimen. S.G.N. 8905/3: phragmocone with remains of body chamber, very well preserved.

Description. — Discoidal shell of medium size, moderately inflated and rather evolute. U/D ratio = 0.36. Whorl section subtrapezoidal with rounded borders, a little wider than high (text fig. 7i). The maximum width occurs at the umbilical border. The umbilical slope is strongly inclined, the umbilicus wide and rather deep.

The flanks are gently convex and rapidly converge to a rounded periphery. The ornamentation is characterized by strong and projected primary ribs that show small radial periumbilical swellings which are more pronounced near the aperture. In the last volution there are 28 to 32 primaries, each of which gives rise to bundles of 4 to 7 secondary ribs, all having the same prominence and an equal spacing. The ribs are somewhat prorsiradiate, especially those more anteriorly situated, and cross the periphery without interruption. In the last whorl there are constrictions, two of which are very clear; these are anteriorly bordered by a more prominent and projected simple rib, and posteriorly bordered by the more anterior of the secondary ribs. The suture line has a trifold L lobe as deep as E, with an E/L saddle wider and higher than the E/U saddle. There are also two U lobes which are very simple and not oblique (see BURCKHARDT, 1903, pl. 6, fig. 12).

Measurements. —

Specimen	n°	D	U	U/D	H	W	H/W
<i>Ch. choicensis</i> (BURCK., 1903)		78	29	0.37	32	34	0.94
S.G.N. 8905/3		66	24	0.36	24	26	0.92

Remarks. — The described specimen corresponds exactly to "*Perisphinctes*" *choicensis* BURCKHARDT (1903, p. 50, pl. 6, figs. 10—12; pl. 8, fig. 6), which is the type species of *Choicensisphinctes* gen. nov. It is very probable that "*Aulacosphinctes*" cf. "*A.*" *choicensis*, described by WEAVER (1931, p. 414) belongs to the species described here. This form also comes from Cerro Lotena (WEAVER, op. cit., p. 415). On the other hand, "*Virgatosphinctes*" cf. *raja* INDANS *non* UHLIG (INDANS, 1954, p. 110, pl. 14, figs. 1—3), from southern Mendoza, Argentina, shows

the morphological characteristics of *Choicensisphinctes* in terms of ornamentation and whorl shape.

Parapallasiceras ? *Danubisphinctes* ? n. sp., *lydi-stratiforme* ZEISS (1968, p. 110, pl. 20, fig. 1), compared by ZEISS (Op. cit., p. 115) to *Virgatosphinctes* cf. *raja* INDANS (non UHLIG), appears to be very closely related to *Choicensisphinctes*.

Occurrence. — Lower part of the Vaca Muerta Formation. Bed 2 of the Cerro Lotena section (Virgatosphinctinae Beds), in association with *V. andesensis*, *V. mexicanus*, *V. burckhardti*, *V. denseplicatus rotundus*, *V. evolutus*, *P. douvillei*, *P. windhauseni*, *P. (?) wilfridi*, *Ch. choicensis sutilis* and *Ch. erinoides*. *Ch. choicensis* is the commonest species found at the base of the Tithonian transgression within the Neuquén and Mendoza basin. It had been found by the author in the sections of Cerro Lotena, Picún Leufú, Mallín de los Caballos, Mallín Quemado, Cajón de Almaza (Neuquén province), Bardas Blancas and Arroyo Cieneguitas (Mendoza province).

Age. — Uppermost Lower Tithonian. *V. mendozanus* Zone.

Choicensisphinctes choicensis sutilis n. ssp.
Pl. 3, Figs. 1a—b, Pl. 4, Fig. 3; Text-Fig. 7h.

Holotype. — *Choicensisphinctes choicensis sutilis* H. LEANZA n. ssp., figured in Pl. 3, Figs. 1a—b of this paper. S.G.N. 8902/1.

Paratype. — *Choicensisphinctes choicensis sutilis* H. LEANZA n. sp., figured in Pl. 4, Fig. 3 of this paper. S.G.N. 8902/2.

Locus typicus. — Southern slope of Cerro Lotena, province of Neuquén, Argentina.

Stratum typicum. — Lower part of the Vaca Muerta Formation. *V. mendozanus* Zone.

Derivatio nominis. — After the fine and elegant ribbing.

Diagnosis. — Shell discoidal, somewhat evolute, with wide umbilicus and strongly inclined umbilical slope. Whorl section subquadrangular, and as high as wide. Ornamentation in the internal whorls composed of very fine and dense ribbing, mostly with dicotomic branching. In the outer whorls are strong and somewhat irregularly-spaced and projected primary ribs, with periumbilical swellings which arise from bundles of 5 to 9 fine and projected secondary ribs. Constrictions are present.

Material. — Two specimens. S.G.N. 8902/1: phragmocone with remains of body chamber, very well preserved, but lacking the test (Holotype). S.G.N. 8902/2: phragmocone fragment and body chamber, laterally crushed (Paratype).

Description. — Discoidal and somewhat evolute shell. U/D ratio = 0.36. The umbilicus is wide and rather deep. The whorl section (text-fig. 7h) is subquadrangular, and as high as wide. The umbilical slope is strongly inclined. The internal whorls are ornamented by fine and elevated ribs which are very densely spaced, most of them with dicotomic branching. In the last whorl the ribs commence in the middle of the umbilical wall, where they are rursiradiate. At the umbilical border they bend forward, producing periumbilical swellings. In this whorl there are an average of 40 primary ribs. In the internal third of the flank there is a branching into bundles composed of 5 to 9 secondary ribs, all of which have the same prominence, being more projected the more anteriorly situated ribs. All the ribs cross the periphery without interruption. Between two contiguous bundles of ribs are intercalatory ribs which, except where they disappear in the upper third of the flank, have the same prominence as the rest of the ribbing. Three constrictions occur in the last whorl; they are prorsiradiate and limited anteriorly by a single prominent rib and posteriorly by the more anterior of the secondary ribs. The body chamber occupies more than half the last whorl, and the aperture shows a projected lappet at the height of the middle third of the flank. The suture line could not be detected.

Measurements. —

Specimen	n°	D	U	U/D	H	W	H/W
S.G.N.	8902/1	71	26	0.36	28	28	1.00
S.G.N.	8902/2	92	33	0.35	36	?	—

Remarks. — The material agrees in its morphological characteristics with the genus *Choicensisphinctes*, but differs from its type species *Ch. choicensis* (BURCKHARDT, 1903, p. 50, pl. 6, figs. 10—12; pl. 8, fig. 6) in being more densely ribbed and in having a whorl section as high as wide. These differences, although small are nevertheless clear and easy to identify. Consequently, the new subspecies of *Ch. choicensis* is proposed.

Occurrence. — Lower part of the Vaca Muerta Formation. Bed 2 of the Cerro Lotena section (Virgatosphinctinae Beds), in association with *V. andesensis*, *V. mexicanus*, *V. burckhardti*, *V. denseplicatus rotundus*, *V. evolutus*, *P. douvillei*, *P. windhauseni*, *P. (?) wilfridi*, *Ch. choicensis* and *Ch. erinoides*.

Age. — Uppermost Lower Tithonian. *V. mendozanus* Zone.

Choicensisphinctes erinoides (BURCKHARDT, 1903)
Pl. 4, Figs. 1a—b; Text-Fig. 7j.

- 1900a *Perisphinctes* aff. *erinus* D'ORBIGNY — BURCKHARDT, p. 42, pl. 25, fig. 1.
1903 *Perisphinctes erinoides* BURCKHARDT, p. 51, pl. 8, figs. 1-4.

- 1907 *Perisphinctes erinoides* BURCKHARDT — HAUPT, p. 197.
 1931 *Perisphinctes erinoides* BURCKHARDT — WEAVER, p. 417.
 1954 *non Virgatosphinctes erinoides* (BURCKHARDT) — INDANS, p. 109, pl. 15, fig. 1 (= *Pseudinvoluceras douvillei*).

Material. — One specimen. S.G.N. 8885/2; relatively well preserved phragmocone with remains of body chamber.

Description. — Large shell, inflated and somewhat evolute. U/D ratio = 0.34. Umbilical slope very high, almost vertical. Rounded umbilical border. Flanks slightly convex, converging gradually to a widely rounded periphery. The maximum width occurs at the umbilical border. The ornamentation is of low relief, and consists of primary ribs with periumbilical swellings which disappear near the middle of the flank, giving way to bundles of 5 to 7 secondary ribs. They are equally spaced and of very low relief, and cross the venter without interruption. The suture line could not be detected.

Measurements. —

Specimen	n°	D	U	U/D	H	W	H/W
S.G.N. 8885/2		120	41	0.34	47	51	0.92
"P." <i>erinoides</i>							
(BURCK., 1903)		160	55	0.34	61	60	1.01

Remarks. — The specimen displays specific characteristics in agreement with "*P.*" *erinoides* BURCKHARDT (1903, p. 51, pl. 8, figs. 1—4). It differs only in having somewhat less dense and sharper ribbing, possibly due to the greater weathering of the BURCKHARDT's specimen. In this latter specimen, the higher whorl section is only present in an advanced ontogenetic stage, while the younger volutions are wider than high (Pl. 8, fig. 3, BURCKHARDT, 1903). This is also characteristic of the specimen described in this study.

The enigmatic species *erinoides* of BURCKHARDT was attributed by different authors to distinct genera such as *Aulacosphinctes* (WEAVER, 1931, p. 417), *Pararaseenia* ? (SPATH, 1927—33, p. 469), *Virgatosphinctes* (INDANS, 1954, p. 109) and *Olcostephanus* (BURCKHARDT, 1930, p. 111, 112). In the opinion of the writer, none of these generic attributions are acceptable. In *Pararaseenia* SPATH, 1925 (type species: *Aulacostephanus zacatecanus* BURCKHARDT, 1906, p. 67, pl. 16, figs. 1—4), there is a tendency towards interruption of the ribs over the venter, resulting in the presence of a smooth band. This feature is completely absent in "*P.*" *erinoides*. With respect to INDANS' classification, reasons were given above for the transference of "*Virgatosphinctes erinoides*" to *Pseudinvoluceras douvillei*. The attributions of this species by WEAVER to *Aulacosphinctes*, and by BURCKHARDT firstly

to *Perisphinctes* and secondly to *Olcostephanus*, appear also to be inadequate, because of the considerable morphological differences with regard to the diagnostic features of these genera.

"*P.*" *erinoides* appear to resemble the genus *Choicensisphinctes* more closely than any other. The similarities of the internal whorl section and ornamentation of "*P.*" *erinoides* with *Choicensisphinctes choicensis* (BURCKHARDT, 1903, p. 50, pl. 6, figs. 10—12; pl. 8, fig. 6) are very clear. A noticeable difference between the two species is however, the suture line, which is more elaborate in "*P.*" *erinoides*.

It is also possible that "*P.*" aff. *erinus* (D'Orb.) BURCKHARDT (1903, p. 52, pl. 9, figs. 1—2; pl. 8, fig. 5) belongs to *Choicensisphinctes*, although it shows a smoother ornamentation, a somewhat more involute shell and a more subtrapezoidal whorl section. *P.* aff. *erinus* was formerly renamed by BURCKHARDT himself (1930, p. 110) as *Craspedites limitis*, but as can clearly be seen, this attribution appears inadequate because of the much different morphologic features of the Boreal genus *Craspedites*.

Occurrence. — Lower part of the Vaca Muerta Formation. Bed 2 of the Cerro Lotena section (Virgatosphinctinae Beds), in association with *V. andesensis*, *V. mexicanus*, *V. burckhardti*, *V. densiplicatus rotundus*, *V. evolutus*, *P. douvillei*, *P. windhausenii*, *P. (?) wilfridi*, *Ch. choicensis sutilis* and *Ch. choicensis*.

Age. — Uppermost Lower Tithonian. *V. mendocanus* Zone.

Genus AULACOSPHINCTOIDES SPATH, 1923

Type species. — *Aulacosphinctes infundibulus* UHLIG, 1910, p. 371, pl. 72, figs. 1a—c.

Aulacosphinctoides aff. *A. hundesianus* (UHLIG, 1910) Pl. 5, Figs. 1a—b; Text-Fig. 7n.

? 1910 *Aulacosphinctoides hundesianus* UHLIG, p. 374, pl. 71, figs. 3a—c; pl. 73, figs. 2a—c.

? 1923 *Aulacosphinctoides hundesianus* (UHLIG) — SPATH, p. 299.

? 1960 *Aulacosphinctoides hundesianus* (UHLIG) — COLLIGNON, pl. 151, figs. 605, 606.

Material. — One specimen. S.G.N. 8934/1: phragmocone and body chamber, relatively well preserved.

Description. — Medium size shell, discoidal and rather evolute. U/D ratio = 0.47. Whorl section subelliptical, somewhat depressed, wider than high (see text-fig. 7n). Umbilical wall strongly inclined, umbilical border rounded with slightly convex

flanks, converging gradually to a widely rounded periphery. The internal whorls are ornamented by narrow and elevated simple ribs, with mostly dicotomic branching in the upper third of the flanks. In the outer whorls, the ribs describe a sigmoidal curve, and in the upper third of the flank they bifurcate or trifurcate, this being more common near the aperture. In the last volution there are 52 primary ribs and 107 secondaries. There are also sharp constrictions anteriorly bordered by a single rib which is more prominent than the other ribs, and which also describes a sigmoidal curve. The calcified nature of the specimen prevented detection of the suture line.

M E A S U R E M E N T S. —

Specimen	n°	D	U	U/D	H	W	H/W
S.G.N.	8934/1	84	40	0.47	28	34	0.82

R E M A R K S. — The specimen coincides exactly with the genus *Aulacosphinctoides* SPATH, 1923 (type species: *Aulacosphinctoides infundibulus* UHLIG, 1910, p. 371, pl. 72, figs. 1a, b). It also shows close affinities with *Torquatisphinctes* SPATH, 1924 (type species: *Ammonites torquatus* J. C. de SOWERBY, 1840, pl. 61, fig. 12). However, *Aulacosphinctoides* differs from this latter genus in having more depressed whorls, sigmoidal ribbing over the flanks, and frequent triplicate branching in the body chamber.

Specifically, the specimen has closer affinities with *A. bundesianus* (UHLIG, 1910, p. 374, pl. 71, figs. 3a—c; pl. 73, figs. 2a—c), included in *Aulacosphinctoides* by SPATH (1923, p. 299), but the specimen from Neuquén differs only in having somewhat narrower ribs, and branching at a level rather higher on the flanks.

A. chidamensis (UHLIG, 1910, p. 376, pl. 74, figs. 1a—d) is also a closely related species, but differs in its wider whorls and much more numerous trifurcate ribs. *A. brownei* (MARSHALL) SPATH (1923, p. 289, pl. 17, figs. 1a—d), from the Tithonian of New Zealand, is very similar to *A. bundesianus*, differing only in its less densely ribbed internal and external whorls.

With regard to the Argentine species, it should be noted that "*Aulacosphinctes*" *colubrinus* WEAVER (*non* BURCKHARDT) (WEAVER, 1931, *partim*, p. 413, pl. 44, fig. 301, *non* pl. 44, figs. 302, 303) probably belongs to *Aulacosphinctoides*. "*Aulacosphinctes*" *cf. bangei* INDANS (*non* BURCKHARDT) (INDANS, 1954, p. 122, pl. 18, fig. 2), as suggested by ARKELL (1956, p. 583), could also be included in SPATH's genus.

O C C U R R E N C E. — Vaca Muerta Formation. Bed 14 of the Cerro Lotena section, in association with *W. internispinosum*.

A G E. — Middle Tithonian. *W. internispinosum* Zone.

Aulacosphinctoides sp. indet.

M A T E R I A L. — One specimen. S.G.N. 8927/1: phragmocone poorly preserved, with internal whorls just discernible and external whorls without test.

D E S C R I P T I O N. — Shell discoidal, strongly evolute. Whorl section not determinable because of crushing of the specimen. Umbilical slope slightly inclined, umbilical border rounded, and flanks gently convex. In the internal whorls the ornamentation is composed of elevated, narrow, irregularly spaced and apparently bifurcate ribs. In the outer whorls, where they can be observed, the ribs are mostly triplicate but some are also biplicate. These ribs describe a gently sigmoidal curve over the flanks. There are also constrictions anteriorly bordered by rather elevated ribs.

R E M A R K S. — The morphological characteristics of this ammonite in general resemble the genus *Aulacosphinctoides*. Although quite similar to the *bundesianus-chidamensis* group, the fragmentary preservation of the specimen does not permit a specific classification.

O C C U R R E N C E. — Vaca Muerta Formation. Bed 12 of the Cerro Lotena section, in association with *Subdichotomoceras araucanense* n. sp.

A G E. — Middle Tithonian. *W. internispinosum* Zone.

Genus SUBDICHOTOMOCERAS SPATH, 1925

T Y P E S P E C I E S. — *Subdichotomoceras lamplughii* SPATH, 1925 (= *Perisphinctes lacertosus* PAVLOW (*non* FONTANNES), in: PAVLOW & LAMPLUGH, 1892, p. 110, fig. on text, p. 111).

Subdichotomoceras windhausenii (WEAVER, 1931)
Pl. 8, Figs. 2a—b; Text-Fig. 7m.

1931 *Aulacosphinctes windhausenii* WEAVER, p. 412, pl. 44, fig. 300.

M A T E R I A L. — One specimen. S.G.N. 8940/2: complete specimen with aperture, moderately preserved.

D E S C R I P T I O N. — Medium size shell, strongly evolute. Whorl section subcircular, as high as wide (see text-fig. 7m). U/D ratio = 0.48. Ornamentation composed of narrow, prominent and rather widely spaced ribs. In the upper third of the flank, each rib bifurcates into two branches which cross the venter without interruption. Both primary and secondary ribs have the same prominence. The aperture is simple and is bordered by a single, much more elevated rib which describes a sigmoidal curve.

Measurements. —

Specimen	n°	D	U	U/D	H	W	H/W
S.G.N.	8940/2	47	23	0.48	17	17	1.00

Remarks. — All morphological features of the specimen agree with "*Aulacosphinctes*" *windhausei* WEAVER (1931, p. 412, pl. 44, fig. 300). Although WEAVER did not figure the ventral view, he stated in his very accurate description that the ribs cross the venter without interruption. For this reason, WEAVER's attribution to the genus *Aulacosphinctes* UHLIG can not be accepted. SPATH (1936, p. 26) and ARKELL (1956, p. 582) have both suggested that "*A.*" *windhausei* could belong to the genus *Pavlovia* ILOVAISKY, 1917 (type species: *P. iatriensis* var. *primaria* ILOVAISKY, 1917, pl. 9, figs. 3a, b). This view has also been accepted by the present author (H. LEANZA, 1973, p. 127, foot note). However, although the described specimen strongly resembles *Pavlovia*, its attribution to the genus *Subdichotomoceras* appears to be more reasonable, because of the more widely spaced ribs in the internal whorls. Indeed, this feature (cf. ARKELL *et al.*, 1957, p. L328) is the only one that can be considered to differentiate the genera *Pavlovia* and *Subdichotomoceras*. The densely ribbed internal whorls of *Pavlovia* are well illustrated in the species from the Kimmeridge Clay of Dorset figured by NEAVEYSON (1925) and COPE (1978) (see *P. rotunda* = *Pallasiceras rotundum* (SOW.) NEAVEYSON, 1925, p. 18, pl. 1, fig. 6).

For the above reasons, the new combination *Subdichotomoceras windhausei* (WEAVER) is therefore proposed. The specimen figured by WEAVER is also from Cerro Lotena, and has the same stratigraphic position as the specimen described here. A species formerly referred to as *Pavlovia* sp. indet., found in Picún Leufú and Mallín Quemado in Neuquén (H. LEANZA, 1973, p. 127), can also be definitely assigned to *Subdichotomoceras* (H. LEANZA & C. HUGO, 1977, p. 253).

These considerations indicate that the genus *Subdichotomoceras* has an areal distribution in the Andean-Madagascan-Himalayan domains during the Lower and Middle Tithonian, while *Pavlovia* is restricted to the Boreal realm in the Upper Kimmeridgian. It is for this reason that the origin of *Pavlovia* from (via) *Pectinatites*, as suggested by COPE (1978, p. 527), appears to be more suitable than an origin from *Subdichotomoceras*, as was formerly postulated by ARKELL *et al.* (1957, p. L332).

Occurrence. — Vaca Muerta Formation. Bed 16 of the Cerro Lotena section, in association with *W. internispinosum*, *Corongoceras lotenoense* and *Parapallasiceras* aff. *P. pseudocolubrinoides*.

Age. — Uppermost Middle Tithonian. *W. internispinosum* Zone.

Subdichotomoceras araucanense n. sp.

Pl. 6, Figs. 1a—b, 3a—b; Text-Fig. 7 l.

Holotype. — *S. araucanense* H. LEANZA n. sp., figured in Pl. 6, figs. 3a—b. S.G.N. 8935/1.

Paratype. — *S. araucanense* H. LEANZA n. sp., figured in Pl. 6, figs. 1a—b. S.G.N. 8906/1.

Locus typicus. — Cerro Lotena, Neuquén province, Argentina.

Stratum typicum. — Middle part of the Vaca Muerta Formation in the Cerro Lotena area.

Derivatio nominis. — From Araucanos, the name given to the Indians from Chile who lived in the area of Neuquén, Rio Negro and Chubut.

Diagnosis. — Shell planulate, strongly evolute. Whorl section subquadrangular with rounded borders. Ribbing strong, sharp, regularly biplicate to the aperture, and without interruption on the venter. Aperture simple, somewhat projected, and without lappets. Constrictions bordered by simple and strong ribs.

Material. — 10 specimens. S.G.N. 8935/1: complete specimen, with phragmocone, body chamber and aperture, very well preserved (Holotype). S.G.N. 8906/1: phragmocone and damaged body chamber (Paratype). S.G.N. 8935/2: phragmocone, moderately preserved. S.G.N. 8935/3: incomplete phragmocone, somewhat deteriorated. S.G.N. 8931/9—13: five specimens, poorly preserved. S.G.N. 8942/8: complete specimen, rather well preserved.

Description. — Shell planulate and strongly evolute. U/D ratio = 0.48 to 0.51. Whorl section subquadrangular, with rounded borders, as wide as high (text-fig. 7 l) or slightly depressed. Umbilical slope gently inclined, umbilical border rounded, and flanks subplanate, gradually converging to a widely rounded periphery. Ornamentation composed of simple, elevated and narrow ribs, which are separated by spaces equal to three times the rib width. In the upper third of the flank each rib bifurcates into two branches which cross the venter without interruption.

The pairs of secondary ribs are somewhat less separated. In the last whorl of the holotype, there are 38 primary ribs and 72 secondaries. There are also constrictions bordered by elevated, strong, and somewhat projected single ribs. The suture line could not be detected.

Measurements. — (better preserved specimens only)

Specimen	n°	D	U	U/D	H	W	H/W
S.G.N. 8935/1 (Holotype)		78	39	0.50	22	22	1.00
S.G.N. 8906/1 (Paratype)		62	32	0.50	16	16	1.00
S.G.N. 8935/2		83	40	0.48	27	27	1.00
S.G.N. 8931/11		84	43	0.51	32	33	0.96

Remarks. — The morphological features of the material described here, undoubtedly resemble those of the genus *Subdichotomoceras* SPATH (1925). Although the material shows close affinities with species from speeton (PAVLOW & LAMPLUGH, 1892), Cutch (SPATH, 1927—33) and Madagascar (COLLIGNON, 1960), it does, however, differ in some aspects from each of them. Therefore a new species is proposed, named *S. araucanense*.

This new species differs from *S. lamplughi* (PAVLOW, in: PAVLOW & LAMPLUGH, 1892, p. 110, text-fig. on p. 111, SD SPATH, 1925, p. 120), which is the type species of *Subdichotomoceras*, in having more elevated, projected and denser ribbing.

Of the species from Cutch figured by SPATH (1927 to 33, p. 521 to p. 526), close resemblances are shown by *S. inversum* SPATH (1927—33, p. 521, pl. 84, figs. 7a, b; pl. 85, fig. 4) and *S. simplex* SPATH (op. cit., p. 522, pl. 83, figs. 8a, b), but these differ in having a lower density of ribs, with the bifurcation at a level somewhat lower on the flanks.

S. n. sp. aff. *S. inversum* SPATH of VERMA & WESTERMANN (1973, p. 183, pl. 30, figs. 1—2; pl. 31, figs. 1—2, text-fig. 14B) from Mexico, has a much more depressed whorl section. The Madagascan species figured by COLLIGNON, v. gr. *S. mandarenense* COLLIGNON (1960, pl. 149, figs. 597—599), differs in being more involute and in having a more depressed whorl section.

Finally, *S. windhauseni* (WEAVER) differs from *S. araucanense* n. sp. in having a lower density of ribs, and a clearly greater angle of divergence of the secondary ribs.

Occurrence. — Vaca Muerta Formation. Bed 12 of the Cerro Lotena section, in association with *Aulacosphinctoides* sp. indet.

Age. — Uppermost Middle Tithonian. *W. inter-nispinosum* Zone.

Subdichotomoceras sp. juv. indet.
Pl. 8, Figs. 5a—b.

Material. — One specimen. S. G. N. 8942/2: well preserved phragmocone of a young specimen.

Description. — Moderate size shell, relatively evolute. U/D ratio = 0.39. Whorl section

suboval, somewhat depressed. Umbilical slope strongly inclined, and the umbilical border, flanks and periphery widely rounded. Ornamentation characterized by elevated and acute ribs, with dichotomic branching throughout the phragmocone. The outer whorl as well as the body chamber is not preserved. Bifurcation occurs in the upper third of the flank, and the secondary ribs cross the venter without interruption. In the internal whorls, the ribs are not densely spaced. Constrictions are present, bordered anteriorly by a single rib.

Measurements. —

Specimen	n°	D	U	U/D	H	W	H/W
S.G.N. 8942/2		46	18	0.39	15	17	0.88

Remarks. — The regular dichotomic branching of the ribs throughout the shell, as well as its whorl section, allow inclusion of this specimen in the genus *Subdichotomoceras*. Because only the inner whorls are preserved, with the evolution of the outer whorls unknown, it is not possible to make a specific classification. The specimen does, however, show some affinities with *S. rebillyi* COLLIGNON (1960, pl. 148, figs. 594—596) from the Lower Tithonian of Madagascar. The latter species differs, however, in having somewhat more depressed whorls.

Occurrence. — Vaca Muerta Formation. Bed 7 of the Cerro Lotena section, in association with *A. proximus*.

Age. — Middle Tithonian. *A. proximus* Zone.

Genus PARAPALLASICERAS SPATH, 1925

Type species. — *Berriasella* (*Aulacosphinctes*?) *praecox* SCHNEID, 1915, p. 64, pl. 3, fig. 5.

Parapallasiceras aff. *P. pseudocolubrinoides*
OLORIZ, 1978
Pl. 8, Fig. 3; Text-Fig. 7p.

? 1978 *Parapallasiceras pseudocolubrinoides* OLORIZ, p. 555, pl. 55, fig. 3, text-fig. on p. 565.

Material. — Three specimens. S.G.N. 8947/1: fragment of phragmocone with body chamber; one side only preserved. S.G.N. 8935/5: complete specimen, but with the inner whorls not well preserved. S.G.N. 8940/5: complete specimen not very well preserved.

Description. — Shell evolute, with wide and shallow umbilicus. U/D ratio = 0.41 to 0.45. Whorl section suboval, a little higher than wide (text-fig. 7p). Umbilical border rounded and flanks slightly convex, gradually converging to a rounded

periphery. Ornamentation composed of elevated, acute, narrow ribs. The ribs normally biplicate or triplicate at a level somewhat above the middle of the flanks, and in a few cases also show polygyrate branching. They commence in the umbilical seam, and are somewhat rursiradiate on the umbilical slope. On the umbilical border they bend forward and cross the flanks radially or a little prorsiradiately, without any inflection. Over the venter the ribs, which display no interruption, describe a small adoral projection. In the inner whorls, however, they become weaker, leading to the formation of a very gentle ventral groove. In specimen S.G.N. 8935/5, there are numerous examples of polygyrate branching. Lappets in the aperture were not observed, but this is probably due to the somewhat incomplete preservation of the body chamber. Constrictions are present in the last whorl. The suture line could not be detected.

Measurements. — (better preserved specimens only)

Specimen	n°	D	U	U/D	H	W	H/W
S.G.N.	8947/1	65	27	0.41	20	?	—
S.G.N.	8940/5	58	25	0.43	17	?	—
S.G.N.	8935/5	75	34	0.45	21	20	1.05

Remarks. — This material, in terms of general shape, most strongly resembles the genus *Parapallasiceras* SPATH, 1925. Although similar to *Torquatisphinctes*, its whorl section is more compressed; furthermore, polygyrate branching is not present in the latter genus. There are even more notable differences with *Berriasella*, which is characterized by a more involute shell, and a somewhat more compressed whorl section and flattened venter, generally with a persistent groove. In addition, branching of the ribs in *Berriasella* occurs on a level rather lower on the flanks.

Although *Parapallasiceras* was originally proposed by SPATH (1925, p. 133), but without an adequate diagnosis, however, it has been recently redefined by ZEISS (1968, p. 105). On the basis of this definition, the described material can be readily included in *Parapallasiceras*.

MAZENOT (1939, p. 41) and DONZE & ENAY (1961, p. 185) considered that *Berriasella praecox* SCHNEID, which is the type species of *Parapallasiceras*, could be included in *Berriasella*, which they considered synonymous with the genus of SPATH. On the other hand, ARKELL *et al.* (1957, p. L329) and ZEISS (1968, p. 105) stated that *Parapallasiceras* has sufficient distinctive features to be considered an independent genus, an opinion which is also accepted here.

Specifically, the closest affinities of the material are with *P. pseudocolubrinoide* OLORIZ (1978, p. 555, pl. 55, fig. 3, text-fig. in p. 565), from the Lower

Tithonian of Southern Spain; this species differs only in having somewhat less dense ribbing. Another species which appears similar to the described material is *P. spurium* (SCHNEID, 1915, p. 81, pl. 10, figs. 5, 5b; pl. 11, figs. 5, 5a), from Neuburg, Germany. This species, however, differs from the Cerro Lotena specimens in having more projected ribbing in the inner whorls and more involute shell.

Occurrence. — Vaca Muerta Formation. Bed 16 of the Cerro Lotena section, in association with *S. windhauseni*, *W. internispinosum* and *C. lotenoense*.

Age. — Uppermost Middle Tithonian. *W. internispinosum* Zone.

Parapallasiceras aff. *P. recticosta* OLORIZ, 1978

Pl. 8, Figs. 6a—b; Text-Fig. 7q.

? 1978 *Parapallasiceras recticosta* OLORIZ, p. 553, pl. 55, fig. 5, text-fig. on p. 565.

Material. — One specimen. S.G.N. 8942/5: well preserved phragmocone, with remains of somewhat damaged body chamber.

Description. — Shell small, evolute, with rather shallow umbilicus. U/D ratio = 0.35. Whorl section suboval, a little higher than wide. Umbilical slope strongly inclined. Umbilical border gently rounded, passing upwards to short flanks which rapidly converge to a rounded periphery (text-fig. 7q). Ornamentation strong, with dichotomic branching throughout the phragmocone. Ribs of the inner whorls are fine, elevated and densely arranged. They are somewhat projected and show dichotomic branching at a level a little above the middle of the flanks. This type of ribbing is essentially the same in the last whorl, but somewhat more widely spaced. The ribs cross the venter with a slight adaperatural convexity, but without interruption. Pairs of secondary ribs are less separated than contiguous pairs, a feature which is clearer in the last part of the last whorl. The angle of divergence of the secondaries is very small. No tuberculation at the point of branching has been observed. The illustration of the ventral view (pl. 8, fig. 6b) represents the undamaged part of the last whorl. In the figured specimen there are 36 primary ribs and 69 secondaries, as well as two clear and deep constrictions. The suture line was not detected.

Measurements. —

Specimen	n°	D	U	U/D	H	W	H/W
S.G.N.	8942/5	39	14	0.35	16	15	1.06

Note: The diameter of the umbilicus was measured on the unillustrated side, where the coiling is more regularly preserved. The height and width of

the last whorl were measured immediately before the deformed portion.

Remarks. — This relatively small, constricted, *Pavlovia*-like specimen can tentatively be included in the genus *Parapallasiceras* SPATH, 1925. Although at first view it resembles *Berriasella nitida* SCHNEID (1915, p. 70, pl. 5, figs. 4, 4b), it does not have simple ribs, the ribbing is less flexuous, and the secondary ribs show less divergence and cross the venter without interruption. Although DONZE & ENAY (1961, p. 188) included this species in the genus *Berriasella* UHLIG, 1905, OLORIZ (1978, p. 608, 609) has recently stated that it belongs to the genus *Lemencia* DONZE & ENAY (1961). Another similarity, although perhaps only superficial, is with the subgenus *Epipallasiceras* SPATH (1936), and in particular with the variety *superba* (SPATH, 1936, p. 57, pl. 39, figs. 2a, b) from the Glauconitic Series of Cape Leslie.

Specifically, the strong nature of the ribbing, the entirely dicotomic branching of the ribs at a level slightly above the middle of the flanks, and the fact that these ribs cross the venter without interruption, relate the specimen to *P. reticosta* OLORIZ (1978, p. 553, pl. 55, fig. 5, text-fig. on p. 565) from the Betic ranges of Southern Spain. The latter species differs from the Cerro Lotena specimen in its more compressed whorls and its denser ribbing in the inner whorls. As only one specimen exists, more detailed comparisons can not be made and it is therefore regarded as *Parapallasiceras* aff. *P. reticosta* OLORIZ.

Occurrence. — Vaca Muerta Formation. Bed 10 of the Cerro Lotena section, in association with *A. euomphalum*.

Age. — Uppermost Middle Tithonian. *W. internispinosum* Zone.

Parapallasiceras sp. indet.

Pl. 7, Figs. 2a—b; Text-Fig. 7 o.

Material. — Five specimens. S.G.N. 8942/4: complete specimen, but with last part of body chamber somewhat damaged. S.G.N. 8942/6—7: two incomplete specimens, poorly preserved. S.G.N. 8942/10: small specimen, moderately preserved. S.G.N. 8944/2: well preserved whorl fragment.

Description. — Shell strongly evolute, with umbilicus very wide and shallow. U/D ratio = 0.45 to 0.49. Whorl section subcircular, as high as wide. Umbilical slope strongly inclined, umbilical border gently rounded, flanks somewhat convex and the periphery slightly rounded (text-fig. 7 o). Ornamentation of inner whorls characterized by simple, acute and elevated ribs, regularly disposed and with bifurcation at a level somewhat below the line of

coiling. In the last whorls, ribbing remains essentially the same up to the body chamber. The ribs commence in the umbilical slope, where they are slightly rursiradiate, but at the umbilical border they bend forward and become clearly prorsiradiate. In the upper third of the flanks the ribs bifurcate, crossing the venter with a somewhat convex form, but without interruption. There are also some sharp constrictions bordered anteriorly by a simple rib which occasionally interrupts the regularity of the rest of the ribbing. The suture line was not detected.

Measurements. — (better preserved specimens only)

Specimen	n°	D	U	U/D	H	W	H/W
S.G.N.	8942/4	55	27	0.49	16	16	1.00
S.G.N.	8942/10	35	16	0.45	12	12	1.00

Remarks. — This rather poorly preserved material is included in the genus *Parapallasiceras* SPATH, 1925 (type species: *Berriasella praecox* SCHNEID, 1915, p. 64, pl. 3, fig. 5) on the basis of its evolute shell, whorl section and mainly biplicate ribbing from the phragmocone to the body chamber. Although it also strongly resembles *Torquatisphinctes* SPATH, 1924 (type species: *Ammonites torquatus* J. C. de SOWERBY, 1840, p. 719, pl. 61, fig. 12), this latter genus has a subquadrangular whorl section, and is more regularly ribbed and lacks polygyrate branching. Although the specimen described here shows some similarities with *T. regularis* ZEISS (1968, p. 51, pl. 7, fig. 2) with regard to its projected ribbing, the latter species shows a very compressed whorl section (cf. ZEISS, 1968, text-fig. 5 on p. 61), a feature that appears to be completely atypical of the true *Torquatisphinctes* from India (cf. SPATH, 1927—33, p. 475 and following), which in general has a subquadrangular whorl section. It is therefore probable that the attribution of ZEISS could be revised.

Considering the lack of better preserved material, the specimens described here are regarded as *Parapallasiceras* sp. indet.

Occurrence. — Vaca Muerta Formation. Bed 18 of the Cerro Lotena section.

Age. — Uppermost Middle Tithonian. *W. internispinosum* Zone.

Genus PACHYSPHINCTES DIETRICH, 1925

Type species. — *P. africanus* DIETRICH, 1925, p. 12, pl. 1, fig. 2; pl. 3, fig. 1. SD SPATH, 1927—33.

Pachysphinctes americanensis n. sp.

Pl. 7, Figs. 1a—d; Text-Fig. 7k.

Holotype. — *P. americanensis* H. LEANZA n. sp., figured in pl. 7, figs. 1a—d, text-fig. 7k. S.G.N. 8952/1.

Locus typicus. — Southern slope of Cerro Lotena, province of Neuquén, Argentina.

Stratum typicum. — Upper part of the Vaca Muerta Formation in the Cerro Lotena area.

Derivatio nominis. — From South America, continent where this species was found.

Diagnosis. — Very large shell, strongly evolute. Whorl section depressed. Internal whorls have regularly biplicate ribbing. Outer whorls display strong, irregularly spaced ribs, with bi- or trichotomic branching. Intercalary ribs also present. In the body chamber the ribbing becomes simple, elevated and distant.

Material. — Two specimens. S.G.N. 8952/1: very well preserved phragmocone fragment with remains of body chamber (Holotype). S.G.N. 8933/2: phragmocone fragment with poorly preserved internal whorls.

Description. — Very large, strongly evolute shell. U/D ratio = 0.51. Umbilicus wide and relatively deep. Internal whorls very depressed, with ornamentation composed of simple, regularly spaced, elevated and somewhat projected primary ribs that at the coiling line bifurcate into two branches. No spines occur at the point of bifurcation. In the last whorl, and particularly in the body chamber, the shape of the shell clearly changes. The whorl section is not as depressed, the umbilical slope is more elevated and strongly inclined, and the umbilical borders is more gently rounded. With regard to the ornamentation, the ribbing becomes stronger and more separated. The ribs commence in the umbilical slope in the areas where the test is preserved. They are initially rursi-radiate, but then bend forward and over the middle of the flank they are clearly projected, crossing the periphery without interruption. In the first half of the last volution the ribs bifurcate or trifurcate; also present are simple ribs which disappear near the middle of the flanks. Towards the end of the last whorl, the ribs are simple and become stronger and much more widely spaced. The suture line is not preserved.

Measurements. — (better preserved specimens only)

Specimen	n°	D	U	U/D	H	W	H/W
S.G.N.	8952/1	196	101	0.51	58	69	0.84

Remarks. — The morphological features of the described material resemble those of the genus *Pachy-*

sphinctes DIETRICH, 1925 (type species: *P. africanus* DIETRICH, op. cit., p. 12, pl. 1, fig. 2; pl. 3, fig. 1), which was later well illustrated by SPATH (1927—33). Eleven species of this genus occur in the Middle Kattol Beds of Cutch. In these beds, *Pachysphinctes* is therefore the most common genus (cf. ARKELL, 1956, p. 388). As noted by SPATH (1927—33, p. 469), *Pachysphinctes* is an intermediate genus between *Kattolicerias* and *Torquatisphinctes*. In adopting the name proposed by DIETRICH for this group, SPATH was influenced not only by the illustration of the genotype, but also by DIETRICH's inclusion in this genus of *P. mülleri* BURCKHARDT (1921, p. 33 = *P. elizabethae* MÜLLER, 1900, p. 529, pl. 15, fig. 4).

The described material undoubtedly belongs to the genus *Pachysphinctes*, and strongly resembles several forms figured by SPATH from Cutch. There is a close resemblance, for example, with *P. bathyplocus* (WAAGEN), reillustrated by SPATH (1927—33, p. 493, pl. 77, figs. 1a—b; pl. 93, figs. 5, 9; pl. 94, fig. 4). However, the specimens from Cerro Lotena differ from the latter species in having more widely spaced ribbing in the last whorl, especially in the body chamber. *P. crassus* SPATH (1927—33, p. 492, pl. 85, figs. 3a—b) is also a closely related species but differs in having distinct periumbilical swellings, stronger ribs, and a more depressed whorl section. Accordingly, it is proposed that the described material be designated as a new species of *Pachysphinctes*, named *P. americanensis* n. sp.

Occurrence. — Vaca Muerta Formation. Bed 22 of the Cerro Lotena section, in association with *W. internispinosum*.

Age. — Uppermost Middle Tithonian. *W. internispinosum* Zone.

Family ASPIDOCERATIDAE ZITTEL, 1895

Subfamily ASPIDOCERATINAE ZITTEL, 1895

Genus ASPIDOCERAS ZITTEL, 1868

Type species. — *Ammonites rogoznicensis* ZEUSCHNER, 1846, in ZITTEL, 1868, p. 117, pl. 24, figs. 4—5.

Aspidoceras euomphalum STEUER, 1897

Pl. 8, Figs. 1a—b; Text-Fig. 10e.

1897 *Aspidoceras euomphalum* STEUER, p. 69, pl. 5, figs. 1-4 (= 1921, trans., pl. 5, figs. 1—4).

1907 *Aspidoceras euomphalum* STEUER — HAUPT, p. 191.

1926 *Aspidoceras euomphalum* STEUER — KRANTZ, p. 432.

1928 *Aspidoceras euomphalum* STEUER — KRANTZ, p. 12.

1931 *Aspidoceras euomphalum* STEUER — WEAVER, p. 436.

Material. — One specimen. S.G.N. 8931/15: well preserved phragmocone with remains of body chamber.

Description. — Medium size shell, inflated, moderately involute, with deep umbilicus. Whorl section suboval, depressed and wider than high. U/D ratio = 0.30. Umbilical slope high and strongly inclined. Umbilical border rounded, with convex flanks, converging strongly to a widely rounded periphery. The maximum width occurs in the middle part of the flanks. Ornamentation consists of two rows of spines, of which the stronger and more prominent are those situated in the middle of the flanks at the maximum width of the whorls. The other row, located at the umbilical border, is characterized by smaller spines which are only half as numerous as those situated in the middle of the flanks. The remainder of the ornamentation consists of striae which are rursiradiate on the umbilical slope and prorsiradiate over the rest of the shell. On the umbilical slope these striae form some folds which tend to disappear in the flank. The suture line could not be detected.

Measurements. —

Specimen	n°	D	U	U/D	H	W	H/W
S.G.N.	8931/15	82	25	0.30	40	50	0.80

Remarks. — The described specimen closely resembles *Aspidoceras euomphalum* STEUER (1897, p. 69, pl. 5, figs. 1—4), particularly with regard to the internal whorls. It differs from *A. andinum* STEUER (1897, p. 70, pl. 5, figs. 5—7) in being more involute and in having a deeper umbilicus, more fine and large spines, and more numerous spines in the interior row. *A. euomphaloides* BURCKHARDT (1906, p. 37, pl. 6, figs. 5—8) is very similar to the described specimen and, as was suggested by KRANTZ (1926, p. 432), could be conspecific with it. On the other hand, *A. quemadense* BURCKHARDT (1906, p. 31, pl. 6, figs. 1—4) undoubtedly belongs to the species *andinum* of STEUER, as was expressed by VERMA & WESTERMANN (1973, p. 192). On the basis of illustrations, *A. neuquensis* WEAVER (1931, p. 435, pl. 52, figs. 341, 342) could also belong to *A. euomphalum*, but WEAVER (op. cit.) has noted in his description that it has more elevated whorls and a more elaborate suture line. *A. longae-vum* LEANZA (1945, p. 26, pl. 2, figs. 1,15), although having a shell of somewhat similar shape, has stronger and less dense spines.

Finally, it should be noted that *A. euomphalum* STEUER (pl. 5, fig. 1) was incorrectly figured in the Treatise of Invertebrate Paleontology (cf. ARKELL *et al.*, 1957, p. L346, fig. 454, 3a—b) as "*Spiticeras* (*Kilianiceras*) *damesi*" (STEUER, 1897).

Occurrence. — Vaca Muerta Formation. Bed 10 of the Cerro Lotena section, in association with *P. aff. recticosta*.

Age. — Upper Middle Tithonian. *W. internispinosum* Zone

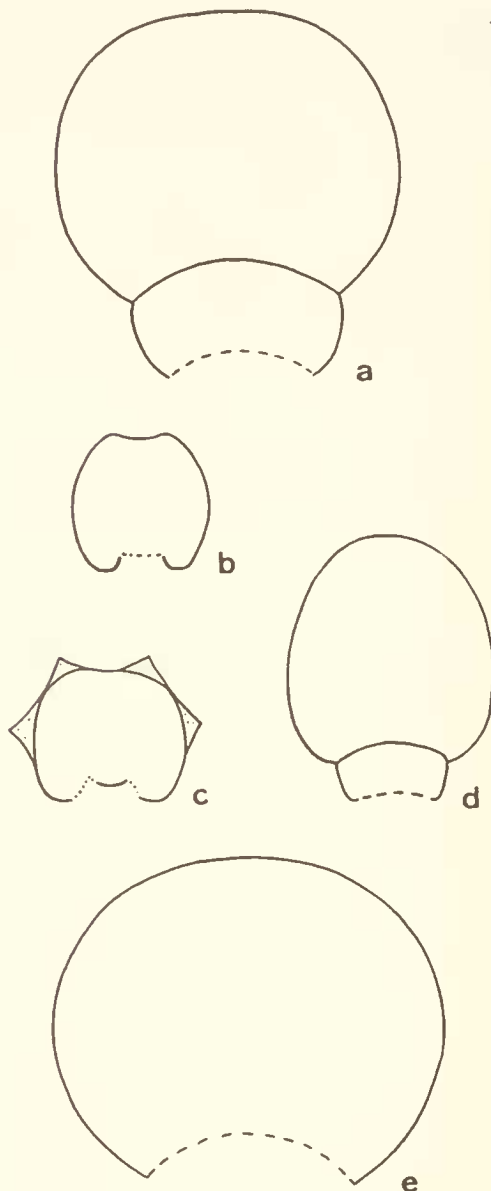


Fig. 10: Whorl sections of Berriassellidae and Aspidoceratidae. a: *Hemispticeras* aff. *H. steinmanni*, S.G.N. 8950/1; b: *Aulacosphinctes proximus*, S.G.N. 8944/1; c: *Corongoceras lotenoense*, S.G.N. 8940/1; d: *Windhauseniceras internispinosum*, S.G.N. 8941/1; e: *Aspidoceras euomphalum*, S.G.N. 8931/15. Natural size.

Family BERRIASSELLIDAE SPATH, 1922
 Subfamily HIMALAYITINAE SPATH, 1923
 Genus WINDHAUSENICERAS A. F. LEANZA, 1945

Type species. — *Perisphinctes internispinosus* KRANTZ, 1926, p. 453, pl. 14, figs. 1, 2; pl. 15, figs. 5, 6 (= 1928, transl., p. 39, pl. 2, figs. 3a, b and 4a, b).

Windhauseniceras internispinosum (KRANTZ, 1926)
 Pl. 8, Figs. 4a—b; Pl. 9, Figs. 1a—b; Text-Fig. 10d.

Material. — This species is, next to *P. zitelii*, the most abundant in Cerro Lotena. The studied collection contains twenty specimens, which are in general well preserved. S.G.N. 8931/1—8: eight moderately well preserved phragmocones. S.G.N. 8933/1: well preserved phragmocone with remains of body chamber. S.G.N. 8934/1—2: very well preserved phragmocone, with remains of body chamber, somewhat distorted. S.G.N. 8935/4: whorl fragments. S.G.N. 8940/3: complete specimen, with internal whorls rather distorted. S.G.N. 8940/4: very well preserved phragmocone (Pl. 8, figs. 4a—b). S.G.N. 8941/1: phragmocone and body chamber, very well preserved (Pl. 9, figs. 1a—b). S.G.N. 8942/1: very distorted specimen. S.G.N. 8948/1: somewhat distorted phragmocone. S.G.N. 8949/1: somewhat crushed but well preserved specimen. S.G.N. 8951/1—2: poorly preserved specimens.

Description. — Shell discoidal, with greater or lesser evolution depending upon whether it represents adult or young stages of growth. U/D ratio ranges between 0.41 and 0.52. Young whorls are wider than high, with very wide and rounded periphery. Flanks strongly convex, gradually converging to a gently inclined umbilical slope. Ornamentation consists of strong, radial and prominent ribs. At the lateroventral border they show a narrow and elevated spine, enlarged radially. From this spine commence two or sometimes three ribs of less prominence than the primary rib; these cross the periphery without interruption. The line of spines can be clearly observed immediately below the line of coiling (see pl. 8, figs. 4a—b).

Outer whorls are higher than wide, with suboval whorl section. The periphery tends to become more acute, and the umbilical slope more strongly inclined. Ornamentation is characterized by rectiradiate or somewhat prorsiradiate, simple or biplicate ribs. The bifurcation takes place in the middle part of the flanks; spines or tubercles are absent. The resulting secondary ribs retain the same prominence as the primaries, crossing the periphery transversally without interruption. Simple ribs extending from the periphery to different levels on the flanks are also present. The aperture is simple, describing only a somewhat sigmoidal curve.

The calcitized nature of the specimens prevented detection of the suture line.

Measurements. — (better preserved specimens only)

Specimen	n°	D	U	U/D	H	W	H/W
S.G.N.	8930/1	93	47	0.50	29	27	1.07
S.G.N.	8931/1	71	37	0.52	22	23	0.95
S.G.N.	8933/1	97	51	0.52	29	28	1.03
S.G.N.	8934/2	108	47	0.43	36	35	1.02
S.G.N.	8940/3	70	32	0.45	24	25	0.96
S.G.N.	8941/1	93	42	0.45	30	?	—
S.G.N.	8948/1	152	74	0.48	54	52	1.03
S.G.N.	8949/1	140	58	0.41	58	56	1.03

Remarks. — The described material is identical to the genus *Windhauseniceras* LEANZA (1945), and coincides specifically with its type species, that is, *Perisphinctes internispinosus* KRANTZ (1926, p. 453, pl. 14, figs. 1, 2; pl. 15, figs. 5, 6 = 1928, transl. p. 39, pl. 2, figs. 3a, b and 4a, b). The type species was also found in the Cerro Lotena area (cf. KRANTZ, 1926, p. 454).

W. internispinosum is very variable depending on its ontogenetic stage, particularly with regard to the ornamentation of the body chamber. It is, in fact, very difficult to find identical specimens. On the other hand, the diagnostic features of the genus always remain the same. Therefore, it was not considered advisory to propose new varieties for the described material. It should be noted, however, that virgato-tomic branching has not been observed, as it has in *W. humphreyi* LEANZA (1949, p. 240, pl. 1, figs. 1, 1a, 2, 2a) from the Tithonian of Arroyo Los Molles, Neuquén, Argentina.

Occurrence. — Vaca Muerta Formation. Beds 9, 14, 16 and 22 of the Cerro Lotena section.

Age. — Uppermost Middle Tithonian. *W. internispinosum* Zone.

Genus HEMISPITICERAS SPATH, 1925

Type species. — *Reineckea steinmanni* STEUER, 1897, p. 28, pl. 8, figs. 1—4.

Hemispiticer aff. *H. steinmanni* (STEUER, 1897)

Pl. 9, Figs. 2a—b; Text-Fig. 10a.

? 1897 *Reineckea steinmanni* STEUER, p. 28, pl. 8, figs. 1-4.

? 1921 *Reineckea steinmanni* STEUER, pl. 8, figs. 1-4.

? 1925 *Hemispiticer* *steinmanni* (STEUER) — SPATH, p. 144 (Gen. nov.).

Material. — One specimen. S.G.N. 8950/1: well preserved phragmocone.

Description. — Discoidal shell, strongly evolute. U/D ratio = 0.49. Inner whorls coronate, similar to those of *Windhausenicer* or *Stephanoc*

ras. Outer whorl section is, by contrast, slightly higher than wide. Umbilical slope gently inclined, umbilical border rounded, but in the inner whorls slightly flattened. Ornamentation characterized by strong, elevated and acute ribs that divide at the line of coiling into two or three branches which are less prominent and wider than the primaries. At the point of furcation are radially elongate tubercles, sometimes poorly preserved. This type of ribbing remains the same in the inner and outer whorls, in contrast to the genus *Windhausenicer*. In the last whorl there are 35 primary ribs and 76 secondaries, which cross the venter without interruption, and display a somewhat adapertural convexity. Calcitization prevented detection of the suture line.

M e a s u r e m e n t s. — (in mm)

Specimen	n°	D	U	U/D	H	W	H/W
S.G.N.	8950/1	140	69	0.49	37	46	0.80

R e m a r k s. — The general shape of the shell of this specimen closely resembles that of the genus *Hemispiticeras* SPATH, 1925 (type species: *Reineckeia steinmanni* STEUER, 1897, p. 28, pl. 8, figs. 1—4), differing only in having smaller and rounded tubercles at the point of the rib furcation. Therefore, the specimen is considered here as *H. aff. H. steinmanni* (STEUER).

Although the inner whorls ornamentation is almost identical to that of *Windhausenicer* LEANZA, 1945 (type species: *P. internispinosus* KRANTZ, 1926, p. 453, pl. 14, figs. 1, 2; pl. 15, figs. 5, 6 = 1928, transl., p. 39, pl. 2, figs. 3a, b and 4a, b). However, in the described material this ornamentation continues in the outer whorls, while in the LEANZA's genus the ribbing loses tubercles, closes together and reverts to a typical *Perisphinctes* style.

Another genus which shows affinities with the described specimen is *Paskentites* IMLAY & JONES, 1970 (type species: *P. paskentaensis* IMLAY & JONES, 1970, p. B47, pl. 13, figs. 11—17), from the Middle Valanginian of the *Buchia pacifica* Zone, in northwestern California and southern Oregon, U.S.A. This genus "... is represented by eight specimens of which most are fragmentary and crushed laterally" (IMLAY & JONES, op. cit., p. B47). Judging from the illustrations, the apparent projection of the ribs — which forms chevrons over the venter — is essentially the only difference from the species described here.

O c c u r r e n c e. — Vaca Muerta Formation. Bed 20 of the Cerro Lotena section.

A g e. — Uppermost Middle Tithonian. *W. internispinosum* Zone.

Genus AULACOSPHINCTES UHLIG, 1910

T y p e s p e c i e s. — *Ammonites mörickeanus* OPPEL, 1863, p. 281, pl. 80, figs. 2a, b. SD SPATH, 1924, p. 16.

Aulacosphinctes proximus (STEUER, 1897)

Pl. 6, Figs. 2a—b, 4a—b and 5a—b; Text-Fig. 10b.

1897 *Reineckeia proxima* STEUER, p. 34, pl. 8, figs. 7-11. (= 1921, transl., pl. 8, figs. 7-11).

1907 *Perisphinctes proximus* (STEUER) — HAUPT, p. 192.

? 1931 *Aulacosphinctes proximus* (STEUER) — WEAVER, p. 411, pl. 44, figs. 298 and 299.

M a t e r i a l. — Ten specimens which are particularly suitable for the study of this genus, are present in the collection. S.G.N. 8922/1: very well preserved phragmocone of young specimen (pl. 6, figs. 4a—b). S.G.N. 8922/2: phragmocone with remains of body chamber. S.G.N. 8944/1: very well preserved phragmocone with remains of body chamber (pl. 6, figs. 2a—b). S.G.N. 8937/1—6: six small specimens, mostly fragmentary and not very well preserved. G.P.I.T. 1545/3: internal mold of phragmocone and body chamber, very well preserved (pl. 6, figs. 5a—b).

D e s c r i p t i o n. — Shell of moderate size, planulate, and strongly evolute. U/D ratio ranges between 0.46 and 0.50. Umbilicus very wide and shallow. Internal whorl section subtrapezoidal, higher than wide. Outer whorl sections somewhat depressed and of subcircular shape (text-fig. 10b). Umbilical slope gently inclined, umbilical border rounded, flanks gently convex and the periphery somewhat flattened. Ornamentation characterized by simple, sharp, acute and fine ribs. They commence in the umbilical seam, cross the umbilical slope in a somewhat rursiradiate manner, bend forward at the umbilical border, and cross the flanks in a recti- or prorsiradiate fashion. Just above the middle of the flanks, most of the ribs bifurcate into two branches of the same shape as the primaries. The more anteriorly situated are prorsiradiate, while those located posteriorly are somewhat rursiradiate. All the ribs are interrupted over the venter, where a shallow groove is developed, which is more pronounced in the inner whorls. Interruption of the ribbing also occurs in the body chamber, although not as clearly (see Pl. 6, Fig. 5b). The number of ribs increases with age. For example, for a diameter of 40 mm there are about 30 primaries, while for one of 60 mm there are about 40. The suture line, observed in the septa limiting with the body chamber, is very simple, displaying an E lobe slightly larger than L, but of the same width. The L/U saddle is two thirds the size of the L lobe.

Measurements. — (better preserved specimens only)

Specimen	n°	D	U	U/D	H	W	H/W
S.G.N.	8922/2	61	31	0.50	17	18	0.94
S.G.N.	8944/1	60	30	0.50	17	18	0.94
S.G.N.	8922/1	43	21	0.48	13	13	1.00
S.G.N.	8937/1	36	17	0.47	12	12	1.00
S.G.N.	8937/6	30	14	0.46	11	10	1.10
G.P.I.T.	1545/3	58	29	0.50	18	19	0.94

Remarks. — The morphological features of the described specimens closely resemble those of the genus *Aulacosphinctes* UHLIG, 1910 (type species: *Ammonites mörickeanus* OPPEL, 1863, p. 281, pl. 80, figs. 2a, b). Although UHLIG stated with regard to the ventral groove that . . . "As is well known, its development is restricted to the chambered nucleus, and does not extend to the body chamber" (UHLIG, 1910, p. 345), in the Cerro Lotena species the ventral groove is apparently also present in the body chamber.

Specifically, the material closely agrees with "*Reineckeia*" *proxima* STEUER (1897, p. 34, pl. 8, figs. 7 to 11) which was transferred in 1910 to the genus *Aulacosphinctes* by UHLIG himself (op. cit., p. 347). Although at first view the material also resembles *Aulacosphinctes colubrinoides* (BURCKHARDT, 1903, p. 57, pl. 10, figs. 9—11), this similarity appears superficial because in this latter species, as indicated by BURCKHARDT's description (op. cit., p. 57), the ribs cross the venter without interruption, a feature which is considered diagnostic to the identification of this genus. It is worth noting that *A. colubrinoides* was transferred by SPATH (1925, p. 145) to the genus "*Crendonites*" BUCKMAN (1923) (= *Glaucolithites* BUCK., 1922), although the same author later stated that it . . . "probably does not belong to this genus, contrary to my previous view" (SPATH, 1936, p. 31). With regard to *A. mörickeanus* (OPPEL), the described species differs in having somewhat rounded flanks, wider whorls, more rapid range of growth, and absence of ribs with tricotomic branching (cf. UHLIG, 1910, p. 351). Another species rather similar to *A. proximus* is *A. parvulus* UHLIG (1910, p. 364, pl. 32, figs. 4a—d) from the Spiti Shales; however, this latter species has a deeper ventral groove and simpler ribbing. With regard to the Madagascan forms, the material described here resembles *A. proximus* (STEUER) var. *angusta* COLLIGNON (1960, pl. 172, fig. 731). The *A. proximus* figured by WEAVER (1931, p. 411, pl. 44, figs. 298, 299) does not display the interruption of the ribs over the venter and therefore its attribution to *Aulacosphinctes* is doubtful. Finally, it can be noted that *A. occultefurcatus* (WAAGEN, 1875, p. 195, pl. 1, figs. 4a, b) from Cutch, India, and *A. wanneri* KRANTZ (1928, p. 42, pl. 2, figs. 6a—b) from Arroyo de la Manga, Mendoza, Argentina, are also closely related species.

Occurrence. — Vaca Muerta Formation. Bed 7 of the Cerro Lotena section, in association with *Subdichotomoceras* sp. juv. indet. and *Laevaptychus crassissimus*.

Age. — Middle part of the Middle Tithonian. A. proximus Zone.

Genus CORONGOCERAS SPATH, 1925

Type species. — *Corongoceras lotenoense* SPATH, 1925, p. 144 (= "*Hoplites köllikeri*" HAUPT, 1907 (non OPPEL), p. 201, pl. 9, figs. 7a—e).

Corongoceras lotenoense SPATH, 1925

Pl. 6, Figs. 6a—b; Text-Fig. 10c.

- 1907 *Hoplites köllikeri* HAUPT (non OPPEL), p. 201, pl. 9, figs. 7a—e.
 1925 *Corongoceras lotenoense* SPATH, p. 144 (Gen. nov., type species).
 1926 *Berriasella* (*Corongoceras*) *lotenoensis* SPATH — KRANTZ, p. 444 (= 1928, transl., p. 28).
 1931 *Berriasella* cf. *köllikeri* (OPPEL) STEUER — WEAVER, p. 444.
 ? 1969 *Corongoceras* cf. *lotenoense* SPATH — HELMSTAEDT, p. 78.

Material. — Two specimens. S.G.N. 8932/1: whorl fragment with remains of body chamber, very well preserved. S.G.N. 8940/1: phragmocone and body chamber, moderately preserved (pl. 6, figs. 6a—b).

Description. — Discoidal shell of medium size, strongly evolute. U/D ratio = 0.50. Umbilical slope gently inclined, with slightly convex flanks and somewhat flat venter (as in *Berriasella*). Whorl section as high as wide (text-fig. 10c). Ornamentation strong, formed by very acute ribs. All ribs bifurcate on the middle of the flanks. At the point of branching an acute tubercle, rather radially elongate, is developed. At the lateroventral border, all secondary ribs show a new row of tubercles elongated transversely to the shell venter; they tend to disappear in the siphuncle. In the last whorl are 24 primary ribs and 40 secondaries. The suture line was not detected.

Measurements. — (better preserved specimens only)

Specimen	n°	D	U	U/D	H	W	H/W
S.G.N.	8940/1	54	27	0.50	18	18	1.00

Remarks. — The whorl section, evolution, number of ribs and general shape of the ornamentation are identical to *Hoplites köllikeri* HAUPT (non OPPEL) (1907, p. 201, pl. 9, figs. 7a—e), also from Cerro Lotena. This species was proposed by SPATH (1925, p. 144) as the type species of *Corongoceras* lo-

tenoense. Therefore, the described material is attributed to this species. "*Reineckeia koellickeri*" STEUER (*non* OPPEL, *non* HAUPT) (1897, p. 31, pl. 8, figs. 5, 6), which was found by BODENBENDER (1892) in Loncoche creek, Mendoza, Argentina, undoubtedly belongs to the genus *Corongoceras*, but differs from the type species in having a more disordered ribbing as well as a larger umbilical diameter. WEAVER (1931, p. 444), stated that *Berriasella* cf. *koellickeri* (OPPEL) STEUER "... occurs in the lower part of the Upper Tithonian strata at Cerro Loteno ...", that is, in a similar stratigraphic position to the described material. WEAVER did not illustrate this species, but in view of his description and the fact that it appears in the same stratigraphic position, it can be included in *Corongoceras lotenoense*. The specimens referred to by KRANTZ as *Berriasella* (*Corongoceras*) *lotenoensis* (KRANTZ, 1926, p. 444 = 1928, p. 28) are also from Cerro Lotena.

Recently, another record of *Corongoceras*, which

probably belongs to the *lotenoense* species of SPATH, was cited from Nepal (HELMSTAEDT, 1969, p. 78).

Corongoceras loetonense (sic) var. *fortior* COLLIGNON (1960, pl. 167, fig. 687), judging by the illustrations, does not appear to belong to the species of SPATH, as it displays greater involution and less divergent secondary ribs. The species referred to as *C. cordobai* by VERMA & WESTERMANN (1973, p. 248, pl. 52, figs. 4, 5; pl. 54, fig. 1, text-fig. 28 B) should not be assigned to *Corongoceras* because of the lack of bifurcation of the ribs, a feature which is considered diagnostic to the identification of this genus.

Occurrence. — Vaca Muerta Formation. Bed 16 of the Cerro Lotena section, in association with *S. windhauseni*, *W. internispinosum* and *P.* aff. *P. pseudocolubrinoides*.

Age. — Uppermost Middle Tithonian. *W. internispinosum* Zone.

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